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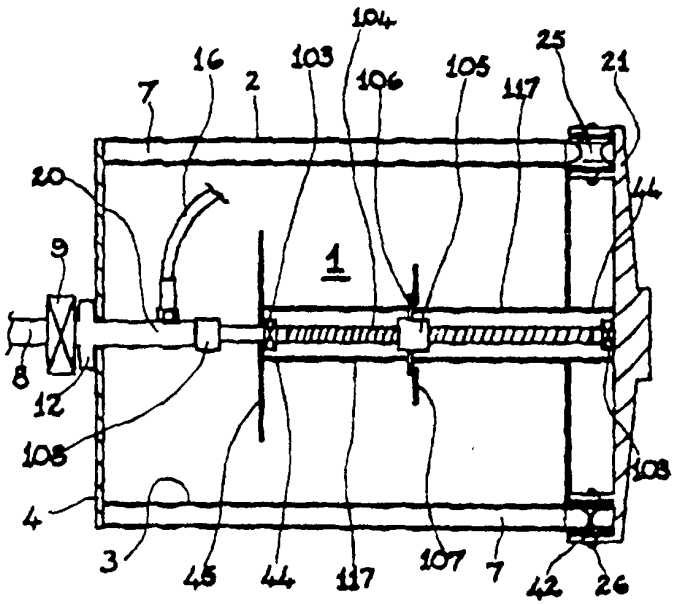


(57) Abstract

Apparatus is disclosed for storing one or more stiffly flexible hoses, cables, rods or the like (16) in the annular space (7) between two rotationally supported coaxial cylinders (2, 3), the coils of said hoses, cables, rods or the like being urged towards an open end of said annular space and into contact with a sequence of independently supported guide rollers (25, 42) by spring or other means acting against a common closure (4) of one end of said cylinders, said hoses, cables, rods or the like being extended from said apparatus by rotation of said cylinders such that they pass from said annular space and around said guide rollers to an annularly disposed exit tube, or retracted into said apparatus through a reversal of this sequence, means (104, 105, 106, 107) being provided to regulate the extension and retraction of said hoses, cables, rods or the like.

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# IMPROVED APPARATUS FOR THE MECHANICAL PROJECTION OF DEVICES THROUGH TUBES, ETC

This invention relates to improvements in apparatus employed to introduce devices for various purposes into and through hollow places, such as tubes, pipes, cavities and the like. More particularly, the invention relates to the need to mechanically push or project devices into such locations in situations in which they cannot be mechanically drawn or pulled in, due, for instance, to lack of ready access for, or difficulty or inconvenience of introducing, cables, lead wires, draw cords and the like. Specifically, the invention is directed towards the introduction of devices into and through the bores of tubes and, more particularly, tubes of smaller diameter such as those incorporated into shell and tube type heat exchangers, condensers, boilers and the like, by attaching them to the distal ends of rigid or stiffly flexible hoses, cables, rods or the like.

In the operation and maintenance of multi-tube industrial heat transfer devices such as heat exchangers, condensers, boilers and the like, it is often necessary to project devices into and through their tubes for the purposes of cleaning their internal surfaces or surveying their condition. Such cleaning devices commonly take the form of

nozzles attached to the ends of rigid or flexible lances and from which high velocity jets of water are emitted to erode away fouling deposits. Devices used to survey the condition of tubes most commonly employ eddy current or ultra-sonic principles. While a variety of devices has been developed to mechanically position and project such cleaning or surveying devices through tubes, the greater part of this type of activity is still performed wholly by hand.

Where devices must be deployed into and through tubes for various purposes, in situations in which cables, lead wires, draw cords and the like may not first be readily or conveniently introduced for the purpose of drawing the devices into and through the tubes, it is necessary for the devices to be mechanically pushed or projected through the tubes. Most commonly, said devices are pushed into and through tubes by mounting them on the distal ends of rigid or stiffly flexible rods, hoses, cables or the like. It is therefore obvious that simple cable or hose reeling devices, which are well known in the art and which cannot impose a projective force upon a cable, hose or the like, such as those exemplified by German Patent No. 492617, British Patent No. 1 299 162 and United States Patent No. 4,767,073, are ineffective in such situations.

For the cleaning of tubes with the use of high

pressure water, various forms of rigid lance projection devices have been developed. The simplest of these, which are well known in the art, employ the same principles as a rock drill, in which a drill stem is attached to and advanced and retracted through the motion of a powered chain. In anoth r form of rigid lance projection device, describ d in United States Patent No. 4,225,362, the proximal end of a rigid lance is attached to a piston in a cylinder, the application of water pressure to one or other side of the piston causing it to pass along the length of the cylinder and the lance to be thereby extended or retracted.

Although such rigid lance projection devices have many advantages, their principal shortcoming is that the large amount of head space required for their deployment renders their use impractical in many situations.

To reduce this head space requirement, flexible lance projection devices have been developed which are of a considerably more compact arrangement. In one such, described in United States Patent No. 3,959,840, a flexible hose is sheathed throughout its length with a coil spring. The combination of hose and spring is coiled within a drum which is free to rotate on a fixed axis. The combination hose and coil spring is led out from the interior of the drum through its axis of rotation, the coils

of the spring engaging th internal threading of a fixed nut positioned on the axis of rotation of the drum. Rotation of the drum in one direction causes the combination of hose and coil spring to be screwably withdrawn from the interior of the drum and projected from the drum, and in the other direction to be restored to the its previous position inside the drum.

The principal shortcoming of this arrangement is that it imposes torsional loadings upon a hose deployed in this way. Many hoses designed to conduct fluids at higher pressures are reinforced with layers of spirally-wound wire. Such hose is intolerant of torsional loadings and may burst if subjected to this mode of stressing whilst pressurised.

Another form of flexible lance projection device is that described in German Patent No. DE 42 11 146 A1 and United States Patent No. 4,691,723. In this type of arrangement, flexible lances are led between pairs of pinch rollers, the rotation of which in one direction causes them to be deployed and, in the other direction, causes them to be restored to their previous position. The shortcoming of this arrangement is that high projective forces imposed upon the lances by the pinch rollers may damage them to be damaged.

In yet a further arrangement of flexible lance projection devic , one or more lances are wound on

a drum and inhibited from radial, and therefore circumferential, movement by a plurality of rollers arranged axially around the drum which bear against them. This arrangement is typified by those described in United States Patents Nos. 4,066,093, 4,103,841 and 5,002,120, European Patent Application No. 91102239.0 and Australian Patent No. 54192/90. All of these devices are characterised by moveable guide means synchronised to drum movement which act to ensure that the lance or lances are laid on the drum in orderly coils and are guided from the drum directly into intermediate guide means through which they are conducted to the pipe or tube to be cleaned. The principal shortcoming of this arrangement is mechanical complexity, in that, unless lances are very stiff, a large number of closely spaced rollers is required to maintain them in place on the drum when projective forces are applied to them. This difficulty is somewhat mitigated in the arrangements described in Australian Patent No. 54192/90, in which the drum is deeply grooved such that the lance is wound into and frictionally captured in the groove, and United States Patent No. 4,066,093 in which the lance is wound into and neatly accommodated in recesses between turns of spirally-wound finning attached to th outer surface of the drum, the finning having a slightly winding running in order to frictionally capture the lance. Both arrangements

act to minimise the tendency towards circumferential shift of the lance on the drum when projective forces are act upon it, and thereby reduce the number of said axially arranged rollers required.

The object of the present invention is to provide a device for the storage and projection of a stiffly flexible element and which is of a light, compact and mechanically simple arrangement, but which permits the application of quite high projective forces to said stiffly flexible element without the necessity to grip its outer surface or to subject it to torsional loadings.

According to the present invention, a drum is made comprising concentric inner and outer cylindrical elements fixed at one end to a base plate, said base plate being fixed, in turn, to a hollow shaft positioned on the common axis of said drum cylindrical elements, said shaft being rotationally supported in a bearing such that the whole assembly is abl to rotate on the axis of the drum. The open end of the drum is supported in a plurality of rollers bearing against the inner, outer or both surfaces of said drum cylindrical elements. The width of the annular spac between said drum inn r and outer cylindrical element is such as to just slideably accommodate the coils of one or more stiffly flexible hoses, cables, rods or the like. Pressurised fluids are supplied, if required, from a suitable source

and through a rotary joint attached to the outer end of said hollow drum shaft and thence via the interior of the shaft to the interior of said drum inner cylindrical element. Alternatively, electric current and/or electrical signals are conducted, if required, to or from the interior of said drum inner cylindrical element through cables passing through the interior of said drum shaft from a rotational connection means incorporating one or more slip rings. The proximal ends of said stiffly flexible hoses, cables, rods or the like are connected, as appropriate, to the inner end of said hollow drum shaft or to the inner surface of said drum base plate and thence passes through an opening in said drum inner cylindrical element to said annular space between said drum inner and outer cylindrical elements. After passing for several turns around said drum annular space, said hoses, cables, rods or the like pass obliquely through and may be clamped to a crowding ring which is slideably accommodated within said drum annular space. Said crowding ring is restrained from rotating independently of said drum by radially disposed lugs which pass through axially disposed slots in said drum inner or outer cylindrical elements. The main body of said hoses, cables, rods or the like is accommodated in said drum annular spac between said crowding ring and the open end of said drum and its

coils are maintained in abutment by pressure from said crowding ring which is urged by suitable means towards said open end of said drum. In a simplified embodiment of the invention, said crowding ring is dispensed with and the coils of a suitable crowding spring are accommodated in said drum annular spac , said hoses, cables, rods or the like passing up through and in parallel with the coils of said spring and their main body being accommodated in said drum annular space between the end of said crowding spring and the open end of said drum. The outermost coils of said hoses, cables, rods or the like bear against a plurality of guide rollers rotationally supported on radially disposed shafts carried in a fix d support frame, or control plate, such that they are more or less equally disposed around the open end of said drum annular space. Said guide rollers are arranged in a sequence such that the first is made in the form of a simple cylinder and each subsequent roller in the sequence is made with a progressiv ly deeper groove such that the outermost coil of said hoses, cables, rods or the like, from a position inside the open end of said drum annular space are, in passing around one turn of said drum and through said guide rollers, progressively displaced in an axial sense under the urging of said crowding ring and spring so as to be, at the final said guide roller in the sequence, completely clear of said

open end of said drum annular space and accommodated within the grooves of said guide rollers.

Rotation of said drum by torque from a suitable motor applied to said drum shaft causes said said hoses, cables, rods or the like to pass from said drum annular space via said guide rollers to a tangentially disposed guide tube fixed to or formed on said control plate and thence via an extended guiding conduit attached to said guide tube to a desired pipe or tube. The said guide roller having the deepest groove formed in it is, in the direction of rotation of said drum required to extend said hoses, cables, rods or the like, the final roller in the sequence situated immediately before said tangentially disposed guide tube.

The various aspects of the present invention will be more readily understood by reference to the following description of preferred embodiments given in relation to the accompanying drawings in which:

Figure 1 is a longitudinal cross-sectional view of the said complete drum assembly;

Figure 2 is a partly cut-away view of the outer surface of said control plate;

Figure 3 is a cross-sectional view of alternative means to support the outer end of said drum;

Figure 4 is a vi w from the side of means to urge said crowding ring towards the open

end of said drum;

Figure 5 is an end view of alternative means to urge said crowding ring towards the open end of said drum;

Figure 6 is a side view of the arrangement depicted in Figure 5;

Figure 7 is a side view of further alternative means to urge said crowding ring towards the open end of said drum;

Figure 8 is a side view of means to secure three said hoses, cables, rods or the like to said crowding ring;

Figure 9 is a side view of three hos s, cables, rods or the like secured by the arrangement depicted in Figure 8;

Figure 10 is is a side view of a single hose, cable, rod or the like secured in an arrangement similar to that depicted in Figure 8;

Figure 11 is an end view of an arrangement to connect a said hose to said hollow drum support shaft;

Figure 12 is a cross-sectional view of a guide roller intended to conduct twin hoses, cables, rods or the like;

Figure 13 is a cross-sectional view of a guide roller intended to conduct triple hoses, cables, rods or the like;

Figur 14 is a cross-sectional view of an alternative, tapered form of said drum;

Figure 15 is a schematic diagram of the preferred general arrangement of the complete invention incorporating the type of drum depicted in Figure 14;

Figure 16 is a schematic diagram of the preferred general arrangement of the complete invention incorporating the type of drum depicted in Figures 1, 17, 18 and 21;

Figure 17 is a longitudinal cross-sectional view of the arrangement depicted in Figure 1, but with an alternative form of control means;

Figure 18 is a longitudinal cross-sectional view of an alternative arrangement of the invention in which, effectively, two drums are combined end to end;

Figure 19 is a transverse cross-sectional view of said drum showing further alternative means to urge said crowding ring towards the open end of said drum;

Figure 20 is a longitudinal cross-sectional view of the arrangement depicted in Figure 19;

Figure 21 is a longitudinal cross-sectional view of an alternative embodiment of said guide rollers;

Figure 22 is a cross-sectional view of the guide rollers depicted in Figure 21;

Figure 23 is a partial longitudinal cross-sectional view of an alternative embodiment of the spring means depicted in Figures 19 and 20.

Figure 24 is a partially sectioned view of the arrangement of a mechanism to detect the application of excessive forces to said hoses, cables, rods or the like.

With reference to Figures 1 and 2, drum 1 is formed from outer cylindrical element 2 made concentric with inner cylindrical element 3, both being attached at one end to base plate 4. Preferably, said outer cylindrical element is permanently attached to said base plate and said inner cylindrical element incorporates circumferential flange 5 which is removably attached to said base plate with fastenings 6, allowing removal of said drum inner cylindrical element. The width of annular space 7 between said outer and inner cylindrical elements is such as to just slidingly accommodate therein coils of a hose, cable, rod or the like 16.

Hollow supporting shaft 8 is rotationally supported in bearing 9 accommodated in housing 10 attached to supporting frame 11. Preferably, said bearing is of the self-aligning type, so as to permit some degree of change in the alignment of shaft 8 in relation to housing 10. Said shaft incorporates

flange 12 attached to base plate 4, the whole arrangement acting to provide rotational support of drum 1. Sprocket, pulley wheel, gear or the like 13 is attached to shaft 8, allowing torque from a suitable motor (not shown) to be applied to said shaft for the purpose of rotating said drum. Rotary joint or rotational connection means 14 for the conduction of fluids or the transfer of electrical current or signals is attached to the outer end of shaft 8 and a flow of fluid or electrical current or signals are conveyed to it through conduit 15.

Hose, cable, rod or the like 16 is captured in clamp 17, the two parts of which are tightened together by fastening 34. Clamp 17 is attached to crowding ring 33 which passes completely around annular space 7. Said clamp passes radially inwards through axially disposed slot 35 in drum inner cylindrical element 3, said slot extending throughout a substantial part of the axial length of said drum inner cylindrical element and the width of said clamp being such as to just allow it to be slideably accommodated in slot 35. Crowding ring 33 is made with two or more projections 37 which pass radially inwards through complementary slots 39 in drum inner cylindrical el ment 3, the inner ends of said projections and th inwardly projecting part of clamp 17 being conn cted to contact ring 36 by fastenings 38. Th width of projections 37 is such as to just

allow them to be slideably accommodated in their complementary slots 39 and said contact ring passes fully around the inside of drum 1 and clear of the inner surface of drum inner cylindrical element 3. Slots 39 extend throughout a substantial part of the axial length of said drum inner cylindrical element. Crowding spring units 40 are attached to base plate 4 and urge contact ring 36 and thereby crowding ring 33 and hose, cable, rod or the like 16 towards the open end of drum annular space 7.

Control plate 21 is fixed to supporting frame 23 by fastenings 29, removal of spacer 22 allowing said control plate to be axially displaced for removal without its movement being impeded by said supporting frame. Said control plate is preferably stiffened by radially disposed ribs 60 formed on its outer face. Formed around the periphery of said control plate are axially projecting flanges 41 and accommodated in the circumferential channel 24 formed between said flanges are guide rollers 25, said guide rollers being rotationally supported on short shafts 26 passing between pairs of flanges 41. Said guide rollers are more or less equally distributed around the periph ry of said control plate and the first such roller 25 is mad more or less in the form of a simple cylinder whilst each succeeding said roller is made with a progressively deep r groove 27 and the groove 28 in the final said roller 42 in the

sequenc is deep enough to fully accommodate hose, cable, rod or the like 16. The axial length of flanges 41 is sufficient to accommodate said guide rollers and such that the inner edges of said flanges remain just clear of the open ends of drum outer and inner elements 2 and 3 and therefore do not impede their rotation. Formed into the outer edge of said control plate adjacent roller 42 is a short, rigid guide tube 64, the position of the inner bore 43 of which is indicated in broken line, said guide tube being made more or less tangential to said control plate and with its axis collinear with that of hose, cable, rod or the like 16 at the point where it passes through groove 28 of roller 42. In the preferred embodiment, provision is made in the form a threaded boss 65 for the connection of a rigid or flexible conduit to the outer end of said rigid guide tube for the purpose of guiding or conducting said hose, cable, rod or the like away from the unit to an application remote from it. Filler block 63 is provided in circumferential channel 24 adjacent the opening formed in outer flange 41 leading to guide tube 64 in order to better direct said hose, cabl , rod or the like out through said guide tube.

Three or more support rollers 30 are each rotationally supported on cranked shafts 31 which pass through control plate 21 and are locked into position by means of nuts and lock nuts 32. The

general axes of said cranked shafts are arranged parallel to the axis of rotation of drum 1 and their mounting positions are such that, by rotating said cranked shafts, support rollers 30 may be displaced outwardly and brought to bear against and maintained in contact with the inner surface of drum inner cylindrical element 3 adjacent its open end and thereby to support said drum with its axis of rotation collinear with that of said control plate. Self-aligning characteristics of bearing 9 permit some degree of displacement of the axis of rotation of drum 1 in order to position it collinear with the axis of said control plate. Prior to disengaging said support rollers from said drum inner cylindrical element, nuts and lock nuts 32 are loosened and said cranked shafts rotated to displace said support rollers inwardly away from said drum inner cylindrical element.

That portion of said hose, cable, rod or the like 16 lying between clamp 17 and inward extension 20 of supporting shaft 8 passes around drum annular space 7 for several turns 18 and thence via a suitable aperture (not shown) in drum inner cylindrical element 3 to the interior of drum 1 where it completes at last one further turn 19 before being attached to said shaft. The number of turns 18 and 19 of said hose, cable, rod or the like provid d is whatever is sufficient to allow full and

unrestrained axial displacement of crowding ring 33 towards the open end of drum annular space 7.

Support column 44 is attached to the inner surface of control plate 21 positioned more or less on the axis of rotation of drum 1 with support plate 45 attached to its inner end. Support rod 48 is captured between boss 46 formed on the inner face of said control plate and bush 49 attached to said support plate. Adjustment rod 50 is provided at its outer end with an adjustment knob (not shown) and at its inner end with a threaded part 51 which extends substantially throughout its length and which engages nut 55 attached to switch support plate 54. Said adjustment rod is rotationally supported in a bearing (not shown) accommodated within boss 47 formed on the inner face of control plate 21 and bush 52 attached to support plate 45. Switch support plate 54 is attached to bearing 53 which is slideably supported on support rod 48, its axial position along said support rod being adjustable by screwing nut 55 along the threaded part 51 of adjustment rod 50 by rotating said adjustment rod. Switch actuation arm 57 is pivotally attached to bearing 53 and rotationally supports at its outer end roller 56. Switch 59 is mounted on switch support plate 54 with switch actuation arm 57 maintained in light contact with it by means of a suitabl spring (not shown), any small displacement of said switch actuation arm

in the appropriate direction acting to trip said switch. In the arrangement depicted, switch actuation is effected by contact ring 36 being axially displaced by movement of crowding ring 33 as hose, cable, rod or the like 16 is retracted into drum annular space 7, causing said contact ring to be brought to bear against roller 56 and thereby causing displacement of switch actuation arm 57. Signals from said switch are transmitted to control means through hoses or cables 58 which pass up and out through the interior of support column 44. In an alternative embodiment providing more precise control of switch 59, the simple form of switch actuation arm depicted in this figure is replaced with a suitable mechanism of a type well known in the art to provide mechanical magnification of movement of roller 56. The arrangement depicted acts to interrupt retraction of said hose, cable, rod or the like into drum annular space 7 at a pr - set length by terminating operation of the motor (not shown) which powers movement of drum 1. A similar switch actuation mechanism (not shown) is also provided within the interior of drum 1 to terminate the paying out of said hose, cable, rod or the like at a pr -set length. In this arrangement, the mechanism is reversed such that contact ring 36, being axially displaced towards the open end of said drum as said hose, cable, rod or the

like is paid out, contacts roller 56 causing switch 59 be tripped and thereby terminates operation of the motor which powers movement of drum 1. Obviously, said switches might be positioned such that they are operated by direct contact with said contact ring.

With reference to Figure 3, in an alternative embodiment, support rollers 30 depicted in Figure 1 are deleted and guide rollers 42 are made wider and larger in diameter and modified by the forming in them of grooves 62 to accommodate the outer edges of drum outer and inner cylindrical elements 2 and 3. The open end of said drum is located and supported in said guide rollers. Said guide rollers may be provided at either side with thrust bearings 61 to better accommodate side loads imposed upon them by drum 1.

With reference to Figure 4, in an alternative embodiment in which greater length of travel of crowding ring 33 is required, spring units 40 as depicted in Figure 1 are deleted and replaced by lazy tong-type units 66 acting through lugs 67, 68 attached respectively to contact ring 36 and base plate 4. Each said lazy tong-type unit is extend d by tension of spring 69 attached to opposed lugs 70 positioned at appropriate points along its length.

With reference to Figures 5 and 6, in a further alternative embodiment in which smaller length of

travel of crowding ring 33 is requir d, spring units 40 as depicted in Figure 1 are deleted and replaced by rattrap-type spring units 71 acting through lugs 67, 68 attached respectively to contact ring 36 and base plate 4. The two halves of said rattrap-type spring units are able to pivot inwardly, as depicted in Figure 5, in order to accommodate their greater width when compressed. Obviously, spring units 40 as depicted in Figure 1 may be replaced by any of the many other forms of linear thrust devices which are well known in the art.

With reference to Figure 7, where a spring unit 40 as depicted in Figure 1 takes the form of a longer compression spring of conventional form, guide tubes 72, 73 attached respectively to contact ring 36 and base plate 4 are provided to confine the coils of spring 40 when high compressive forces are imposed upon them. The diameters of said guide tubes are made such that the smaller, 72, is able to telescopically enter the larger, 73, and the mouth of guide tube 73 is preferably flared to facilitate entry of the other. Both said guide tubes may be mounted against resilient pads 78 which permit a small d gree of radial accommodation in the longitudinal axes of said tubes to ensure that they are able to co-operate telescopically without interference.

With reference to Figure 8, a clamp unit to clamp three hoses, cables, rods or the like comprises

parts 17a, 17b, 17c, 17d articulated at their inn r ends on pivots 74 and clampable together with clamping bolt 34. Obliquely arranged jaws 75 to accommodate and grip said hoses, cables, rods or the like are formed in the opposed faces at the outer ends of said clamp parts. Said pivots are such as to ensure that the sides of said clamp parts remain in accurate alignment when they are clamped and the width of said clamp is such as to just allow it to be slideably accommodated in slot 35 as depicted in Figure 1.

With reference to Figure 9, hoses, cables, rods or the like 16a, 16b, 16c pass obliquely through and are captured in the jaws of triple clamp 17, said clamp being attached to crowding ring 33 of which parts 76 and 77 are shaped or cut away to accommodate the entry to and exit of said hoses, cables, rods or the like from the jaws of said clamp. Said clamp passes radially inwards to the interior of drum 1 through an axially disposed slot in said drum inner cylindrical element and the position 35 of said slot is indicated in broken line.

With reference to Figure 10, a hose, cable, rod or the like passes through and is captured in the obliquely arranged jaws of a single clamp, 17, said clamp being attached to crowding ring 33, part of which 91 is cut away and shaped to accommodate the exit of said hose, cable, rod or the like from

th jaws of said clamp. Filler block 90 is provided as an extension of said clamp to support the n xt turn of said hose, cable, rod or the like. Said clamp passes radially inwards to the interior of drum 1 through an axially disposed slot in said drum inner cylindrical element and the position 35 of said slot is indicated in broken line. In an alternative embodiment, rollers 79 are provided in said clamp and co-operate with the edges of slot 35 to reduce friction during axial displacement of said clamp along said slot.

With reference to Figure 11, in another alternative embodiment of the invention in which only a short length of lance is to be stored and paid out, and preferably in which a tapered drum as depicted in Figure 14 is employed, it is possible to dispense with crowding ring 33, contact ring 36, spring units 40, clamp 17, support column 44, support plate 45, support rod 48, adjustment rod 51, nut 55, bearing 53, switch support plate 54, switch 59 and all of their associated minor components and fastenings as depicted in Figure 1. In this embodiment, hollow extension bar 87 is connect d to shaft xtension 20 and extends radially to almost contact the inner surface of drum inner cylindrical element 3. Hose, cable, rod or the like 16 is connected to the outer end of said hollow ext nsion bar and pas es thenc via opening 88 in said drum

inner cylindrical element to drum annular space 7. The edges of opening 88 may be provided with inwards or outwards deflections 89, as appropriate, to minimise chafing of said hose, cable, rod or the like against them. In operation, said hose, cable, rod or the like is retracted into and stored in said drum annular space, the tendency of its coils to spring outwards due to their stiff flexibility causing it to be distributed in more or less parallel coils. During paying out or retraction of said hose, cable, rod or the like, an operator monitors its exposed length and terminates drum motion as appropriate. The attachment of said hose, cable, rod or the like at the outer end of said hollow extension bar and approximately tangential to said drum annular space restrains said hose, cable, rod or the like against circumferential shift and allows it to sustain moderate compression forces during its paying out without danger of its being forced back into the interior of drum 1. Obviously, said hose, cable, rod or the like is restrained against other than minor circumferential shift when tensile forces are imposed upon it during retraction. In this embodiment, where automatic interruption of paying out and retraction of said hose, cable, rod or the like is desired, the simpler control mechanism depicted in Figure 17 may be employed.

With reference to Figure 12, where it is desired

to be able to pay out and retract and store twin hoses, cables, rods or the like 16a, 16b, control plate depicted as feature 21 in Figure 1 is provided with a plurality of guide rollers 80 capable of accommodating two such hoses, cables, rods or the like. In this embodiment, said guide rollers are made wider, the first in the sequence being made more or less cylindrical and then each successive guide roller having a progressively deeper groove 81 formed in it to accommodate a single hose, cable, rod or the like 16a and then progressively widening to accommodate a second, parallel hose, cable, rod or the like 16b. Preferably, in order to make use of the tendency of coils of the stiffly flexibl said hose, cable, rod or the like to spring out to a larger diameter, widening of said guide roller groove is made towards the outside of drum annular space 7. Each said guide roller is supported on a shaft (not shown) passing through bore 83 in it. To confine the outer hose, cable, rod or the like 16a in groove 81 of said guide roller, a radial flange 82 is formed on the outer edge of drum outer cylindrical element 2.

With reference to Figure 13, where it is desired to be able to pay out and retract and store triple hoses, cables, rods or the like 16a, 16b, 16c, control plate depicted as feature 21 in Figure 1 is provided with a plurality of guide rollers 84

capabl of accommodating three such hoses, cables, rods or the like. In this embodiment, said guide rollers are made wider, the first in the sequence being made more or less cylindrical and then each successive guide roller having a progressively deep r groove 85 formed in it to accommodate a single hose, cable, rod or the like 16a and then progressively deepening and widening to accommodate second and third parallel hoses, cables, rods or the like 16b, 16c. Preferably, in order to make use of the tendency of coils of the stiffly flexible said hose, cable, rod or the like to spring out to a larger diameter, widening of said guide roller groove is made towards the outside of drum annular space 7. Each said guide roller is supported on shaft 26 passing through bore 83 in it. Washers or thrust bearings 86 are provided between the side faces of said rollers and flanges 41 formed on control plate 21. To confine the outer hose, cable, rod or the like 16b in groove 85 of said guide roller, a radial flange 82 is formed on the outer edge of drum outer cylindrical element 2.

With reference to Figure 14, where only short lengths of said hose, cable, rod or the like are to b stored and paid out, a simpler embodiment of the invention may be employed in which drum 1 comprises tapered outer and inn r cylindrical elements 2, 3, fixed to base plate 4, the larger

diam ters of said tapered cylindrical elements being towards their open ends. In this embodiment, support rollers depicted as feature 30 in Figure 1 are deleted and said drum is rotationally supported on said shaft, flange 12 of which is fixed to said drum base plate. Said shaft is rotationally supported in suitable bearings (not shown) which maintain the axis of rotation of said drum in accurate alignment with the axis of control plate 21. Suitable frame members support said bearing and said control plate such that said drum and said control plate are maintained in accurate juxtaposition and said drum is free to rotate without interference. Said drum is rotated by torque from a suitable motor (not shown) applied through a sprocket, pulley wheel, gear or the like (not shown) fixed to said shaft. Guide rollers 25 are housed in circumferential channel 24 between flanges 41 formed on the outer edges of said control plate, said guide rollers being rotationally supported on short shafts (not shown) passing between adjacent said flanges. Preferably, but not necessarily, circumferential channel 24 is made tapered so as to be more or less an axial continuation of drum annular space 7 and said guide rollers ar positioned within it such that a line passing through their c ntres normal to their axes of rotation will pass up th centre of said drum annular space. In this embodiment, a said hose,

cable, rod or the like wound into and stored in said drum annular space will, because of its stiffly flexible nature and the tapering of said drum, always tend to locate its coils at the zone of largest diameter adjacent said guide rollers. In order to gain the added assistance of gravity in maintaining the coils of a said hose, cable, rod or the like adjacent said guide rollers, preferably said drum is mounted with its supporting shaft 8 uppermost and its axis of rotation maintained more or less vertical. Where no control mechanism is employed, during paying out or retraction of said hose, cable, rod or the like, an operator monitors its exposed length and terminates drum motion as appropriate. In this embodiment, where automatic interruption of paying out and retraction of said hose, cable, rod or the like is desired, the simpler control mechanism depicted in Figure 17 may be employed.

With reference to Figure 15, an embodiment of the invention, in which the tapered conical drum arrangement depicted in Figure 14 is employed, is depicted in schematic form. In this embodiment, drum 1 is supported on shaft 8 with its axis of rotation maintained more or less vertical and rotationally supported in bearings (not shown) carried in a bearing housing (not shown) fixed to upper frame members 99. Sprocket, pulley wheel, gear or the like 13 is fixed to shaft 8 and driven

by chain 93 powered by motor 94. Upper frame members 99 are connected by side frame members 96 to base frame members 95. Control plate 21 is supported in said base frame members generally in the arrangement depicted in Figure 14. Apertures are provided in said control plate from said circumferential channel (depicted as feature 24 in Figure 14) to allow escape of liquid or solid material brought into the unit during operation by the retraction into it of said hose, cable, rod or the like. Fluid, electrical current or electrical signals enter the unit through conduit 15 and pass to the interior of drum 1 via rotary joint or rotational connection means 14. Said hoses, cables, rods or the like pass into and out of the unit through rigid guide tube 64 and conduit 92 connected to said guide tube by connection means 65. Rear side frame members 96 are extended upwards to create handle 97, wheels 100 are rotationally fixed to axles (not shown) at the rear of the unit and stand 98 is provided at the front to support and maintain said base frame members in a more or less horizontal attitude.

With reference to Figure 16, an embodiment of the invention, in which the parallel cylindrical drum arrangements depicted in Figures 1, 2, 17, 18 and 21 are employed, is depicted in schematic form. In this embodiment, drum 1 is supported on shaft

8 with its axis of rotation maintained more or less horizontal and rotationally supported in bearings (not shown) carried in a bearing housing (not shown) fixed to side frame members 96. Sprocket, pulley wheel, gear or the like 13 is fixed to shaft 8 and driven by chain 93 powered by motor 94. Upper frame members 101, 102 are connected by side frame members 96 to base frame members 95 and are preferably made readily detachable to facilitate removal of said drum assembly from the invention. Control plate (not shown) is supported in said side frame members on the opposite side of the unit. Said hoses, cables, rods or the like pass into and out of the unit through rigid guide tube 64 and conduit 92 connected to said guide tube by connection means 65. Rear side frame members 96 are extended upwards to create handle 97, wheels 100 are rotationally fixed to axles (not shown) at the rear of the unit and stand 98 is provided at the front to support and maintain said base frame members in a more or less horizontal attitude.

With reference to Figure 17, in an alternative embodiment of the invention, a different form of apparatus is provided to allow automatic interruption of paying out and r traction of said hoses, cables, rods or the like. In this embodiment, th arrangement is generally in accordance with that depicted in Figures 1, 17, 18 and 21, excepting that support

column 44 is made with two or more axially disposed slots 117 extending throughout the greater part of its length and with bearings 103 positioned at each end of it and collinear with it. Threaded rod 104 is rotationally supported in said bearings and connected to the end of hollow shaft inward extension 20 by coupling 108 and nut 105 is screwably supported on said threaded rod. Support arms 106 extend radially from said nut out through axially disposed slots 117 to support contact ring 107, which passes fully around but clear of said support column. Support plate 45 fixed to the inner end of said support column supports the following features (not shown) as depicted in Figure 1 - support rod 48, adjustment rod 51, nut 55, bearing 53, switch support plate 54, switch 59, roller 56 and switch actuation arm 57. Rotation of drum 1 causes nut 105 to be screwably displaced on threaded rod 104, displacing contact ring 107 until it is brought to bear against roller 56 causing displacement of switch actuation arm 57 and thereby interrupting drum motion. Two such control mechanisms are provided in opposed senses to interrupt drum motion at two pre-set magnitudes of inward and outward displacement of said nut.

With ref rence to Figure 18, yet a further alt rnative embodim nt of th invention is provid d in which one or more hoses, cables, rods or the like

16 are slideably accommodated in the form of coils in drum annular space 7 formed between outer cylindrical element 2 and inner cylindrical element 3, entering said drum annular space tangentially to said drum and parallel and adjacent to each other (entry and exit position depicted in broken line 116) through a circumferential opening 115 of suitable width in said drum outer cylindrical element. Said circumferential opening is positioned centred on a dividing plane normal to the rotational axis of drum 1 which divides said drum into two cylindrical parts of more or less equal length. Said hoses, cables, rods or the like are wound into coils, the innermost of which abut at said dividing plane at the point of entry to said drum annular space and successive turns of which are positioned progressively away from said dividing plane. Preferably, in this embodiment, said hoses, cables, rods or the like are provided in multiples of two, with successive turns of one, two or three such in parallel formed to either side of said dividing plane, giving a total, respectively, of two, four or six which may be stored and deployed. Obviously, it would be possible to accommodate unequal numbers of said hoses, cables, rods or the like on either side of said dividing plane and, for instance, there is no reason why three such should not be accommodated, with successive turns of two in parallel on one

side of said dividing plane and one on the other. Other combinations are obviously possible, the maximum number of said hoses, cables, rods or the like being limited by the length of said drum. In this embodiment, crowding rings 33 are accommodated in said drum annular space positioned outwardly of said coils of said hoses, cables, rods or the like, their width being such as to permit their fr e sliding movement. Said crowding rings may embody clamps as depicted in Figures 8, 9 and 10 to attach said hoses, cables, rods or the like to them or may simply be provided with suitable oblique openings through which said hoses, cables, rods or the like pass into said drum annular space outwards of said crowding rings. Where said clamps are provided, a complementary slot is also provided in said drum inner cylindrical element to accommodate its inward radial extension 109. Suitable access openings (not shown) are provided in drum inner cylindrical element 3 towards its ends to permit egress of said hoses, cables, rods or the like from said drum annular space. After passing in several turns around said drum annular space outwards of said crowding rings, said hoses, cables, rods or the like pass out through said access openings and pass via the inner space of said drum inner cylindrical element to be connected to hollow shaft 20 or to a manifold or other terminal provisions fixed to it. Said drum

inner cylindrical element is provided with a plurality of axially disposed slots 39 which extend throughout a substantial part of its length and radial projections 109 fixed to said crowding rings pass radially inwards through said slots to th interior of said drum inner cylindrical element. Optionally, said radial projections may all be fixed at their inner ends to a contact ring such as that depicted as feature 36 in Figure 1, said contact ring passing completely around the interior of said drum inner cylindrical element but clear of its inner surface. Crowding springs 110 (of which only one is shown) apply force to said radial projections or to said contact ring and thereby to said crowding rings to urge them and said hoses, cables, rods or the like inwards towards said dividing plane. In alternative embodiments, other crowding spring arrangements, such as those depicted in Figures 1, 4, 5, 6, 7, 19 and 20 are employed.

Said drum outer and inner cylindrical elements are fixed at one end to base plate 4 and, at the other, open, end, are joined by annular connecting ring 119. Flange 12 formed on shaft 8 is fixed to said base plate and said shaft is rotationally supported in bearing 9. Control plate 21 is maintained in fixed juxtaposition with said open end of said drum and support rollers 30 rotationally supported on shafts 31 fixed to said control plate

bear against the inner surface of said drum inner cylindrical element. Preferably, said shafts on which said support rollers are rotationally supported are made as depicted in Figure 1 such as to allow independent radial adjustment of the positions of said support rollers against the inner surface of said drum inner cylindrical element. Said drum is rotated by torque from a suitable motor (not shown) applied to said shaft through a suitable sprocket, pulley wheel, gear or the like (not shown).

A plurality of guide rollers 111 is distributed around the circumference of circumferential opening 115 and act generally to prevent any radial displacement of said hoses, cables, rods or the like during the application of projective forces to them. Obviously, the number and spacing of said guide rollers is dependent generally upon the stiffness of said hoses, cables, rods or the like. An opening is provided in the regular sequence of said guide rollers at the point of tangential entry to or exit from said drum of said hoses, cables, rods or the like. Said guide rollers are rotationally supported on shafts 114 carried in fixed frame 113 which pass s substantially around the circumf rence of said drum. One or more radially dispos d guides (not shown) may be fixed to said frame at the point of tang ntial entry to or exit from said drum of said hos s, cables, rods or the like. Said guide rollers are

provid dwith medial d velopm nts 112 normal to their axes of rotation and positioned on said dividing plane, such that they pass between paired groups of said hoses, cables, rods or the like and act to wedge them apart and thereby displace them outwards from the region of circumferential opening 115 and into said drum annular space against the urging of said crowding springs. Preferably, the initial said guide roller, positioned adjacent and immediately after, in the direction of winding, the said point of entry to or exit from said drum of said hoses, cables, rods or the like, is made in the form of a simple cylinder which just contacts the outer surface of said hoses, cables, rods or the like over more or less the width of circumferential opening 115. The next in the said sequence of guide rollers in the direction of winding of said hoses, cables, rods or the like is made with a narrow radial development 112 which passes between paired groups of said hoses, cables, rods or the like and separates them and displaces them axially a small distance in the manner previously described. Each subsequent roller in the direction of winding in the said sequence of guide rollers is made with a progressively wider said radial development such that paired groups of said hos s, cables, rods or the like are progressively displaced outwards from the region of circumferential opening 115 and into said drum

annular space against the urging of said crowding springs. The final roller in said sequence of guide rollers, positioned adjacent and immediately before the said point of entry to or exit from said drum of said hoses, cables, rods or the like is made in the form of a simple cylinder which just contacts the outer surface of said drum inner cylindrical element over more or less the width of said circumferential opening. In entering said drum, said hoses, cables, rods or the like pass over said final guide roller and beneath said initial guide roller.

Control means as depicted in Figures 1 or 17 are provided to terminate the extension from and retraction back into said drum of said hoses, cables, rods or the like at pre-set distances.

With reference to Figures 19 and 20, in a further alternative embodiment, hoses, cables, rods or the like are slidingly accommodated in the form of coils in annular space 7 formed between outer cylindrical element 2 and inner cylindrical element 3 of drum 1. Said drum outer and inner cylindrical elements are fixed to base plate 4 and the whole assembly is rotationally supported on shaft 8. Crowding ring 33 is slideably accommodated in said drum annular space and is provided with a plurality of projections 37 which pass radially inwards through complementary slots 39 in said drum inner cylindrical

element to its int rior. Spring attachment holes 120 are provided at the inner ends of said radial projections. A plurality of crowding springs, preferably arranged in pairs and each comprising coil 121, axially disposed standing part 122 and spring arm 123, is provided accommodated within the interior of said drum inner cylindrical element, the inner end of said standing part being pivotally supported in attachment bracket 118 fixed to said base plate and secured by a nut 129 and washer 130 or some other suitable attachment provision. The length of said standing part is made such that the centre of said coil is positioned more or less at the median position of axial travel of said crowding ring. The attachment of said spring arm to said coil is such that, when said coil is unloaded, it adopts a position more or less collinear with said standing part. During axial travel of said crowding ring from one extremity of movement to another, displacement of said spring arm causes the centre of said coil to be displaced radially, describing a short arc, and hook 124 formed on the outer end of said spring arm to pivot through holes 120 in said radial projections.

With reference to Figures 21 and 22, in still another alternative embodiment, drum 1 comprises inner cylindrical element 3 and outer cylindrical element 2 fixed to a base plate (shown as feature

4 in Figure 20), the axial length of said drum outer cylindrical element being made shorter at the open end of said drum than that of said drum inner cylindrical element by a little more than the length of guide rollers 126, a plurality of which are provided around the outer circumference of said drum adjacent control plate 21 and rotationally supported on shafts 31 positioned parallel with the axis of rotation of said drum and fixed to said control plate. The length of said guide rollers is such as to more or less equal the combined diameters of the number of said hoses, cables, rods or the like accommodated in said drum annular space and said guide rollers cooperate with said hoses, cables, rods or the like exposed at the open end of said drum due to the said reduced length of said drum outer cylindrical element and act to maintain them against said drum inner cylindrical element. Said hoses, cables, rods or the like enter said drum through a tangentially disposed guide tube attached to said control plate, (similar to that depicted as feature 4 in Figure 2), the general position 128 and bore 127 of which are indicated respectively in Figure 20 in broken line and pass beneath the first said guide roller 126a, which is made in the form of a simple cylinder. The next said guide roller in sequence in the direction of winding of said hoses, cables, rods or the like is provided

with a narrow radial projection at its outer end adjacent said control plate which acts to displac said hoses, cables, rods or the like a small distance away from said control plate and into said drum annular space against the urging of said crowding springs, where provided. Each subsequent said guid roller (126b and 126c are typical) in sequence in the direction of winding of said hoses, cables, rods or the like is provided with a similar radial projection at its outer end of progressively increased width such that said hoses, cables, rods or the like are progressively displaced into said drum annular space and the final said guide roller 126d immediately adjacent said tangentially disposed guide tube is made in the form of a simple cylinder which more or less fills the space which would normally be occupied by the first turns of said hoses, cables, rods or the like, ensuring that said hoses, cables, rods or the like are fully displaced into said drum annular space. Said guide rollers, in bearing against the turns of said hoses, cables, rods or the like act to support the open end of said drum and maintain its axis of rotation collinear with that of said control plate. Obviously, a separate support roller might be provided rotationally supported on each shaft 31 between a said guide roll r and said control plate to bear against the outer surface of said drum inner cylindrical element

and thereby positionally support the open end of said drum. Obviously, also, said guide rollers might be made longer with said support rollers incorporated into them.

With reference to Figure 23, in a modified version of the embodiment depicted at Figures 19 and 20, crowding ring (depicted as feature 33 in Figure 20) is deleted and a suitable fitting 125 is provided on the end of spring arm 123 to directly engage an appropriate coil of said hose, cable, rod or the like. In the Figure, fitting 125 is depicted as a hook, but it might also take the form of a pivotally attached pressure pad accommodated within said drum annular space and ranging in width, in terms of circumferential extent, from narrow to extending around up to one third of the circumference of said drum annular space. This arrangement may be employed where said crowding ring is deleted.

Obviously, in all embodiments of the invention, said drum inner and outer cylindrical elements can be made from a plurality of discrete, axially arranged elements attached to a baseplate (as feature 4 in Figure 1) and approximating a cylinder in shape.

Where it is d sired to store, extend and retrieve only a r latively short length of hose, cable, rod or the like, said crowding ring may be dispensed with and the coils of a suitable crowding spring accommodated in said drum annular space, said

hoses, cables, rods or the like passing up through and in parallel with the coils of said spring and their main, dispensable, body being accommodated in said drum annular space between the end of said crowding spring and the open end of said drum. Preferably, said crowding spring is stiff and consists of only two to three turns. Said crowding spring acts to urge the the coils of said hose, cable, rod or the like stored in said drum annular space out through the open end of said drum annular space and into co-operation with said guide rollers.

The hoses, cables, rods or the like stored in, extended from and retrieved back into said drum annular space may have only a limited capacity to sustain compressive forces without sustaining damage. It is a known defect of the class of machine in which the present invention is included that such machines are capable of imposing compression or tension forces upon the hoses, cables, rods or the like stored in them of sufficient magnitude to cause crippling or tensile damage. Such damage occurs, for example, when a hose, cable, rod or the like is projected into a tube which is obstructed and its extension is suddenly arrested, or during retraction from a tube if its movement is suddenly arrested as a r sult of the wedging effect of pieces of solid material in said tube. In order to minimise the potential for damage to said hos s, cables, rods or the like,

the invention embodies a device to detect excessive forces in said hoses, cable, rods or the like and thereby to cut off power to the motor applying torque to said drum and, preferably, to also immediately arrest the rotation of said drum by applying braking means to it. Devices to detect excessive forces in said hoses, cables, rods or the like may take a variety of forms. In the preferred embodiment depicted in Figure 24, a curved part of said hoses, cables, rods or the like 16 (shown in broken line) is led through roller 131 which is rotationally supported on the outer end of sprung plunger 132. Switches or valves 133 are positioned adjacent a striker bar 134 fixed to said sprung plunger and centralising springs 135 act to maintain said sprung plunger in its rest position. Excessive compressive force applied to said hoses, cables, rods or the like causes their said curved part to be deflected outwardly, causing said roller and said sprung plunger to be outwardly displaced and, thereby, for said striker bar to contact and operate one of said switches or valves. Conversely, excessive tension force applied to said hoses, cables, rods or the like causes their said curved part to be deflected inwardly, causing said roller and said sprung plung r to be displaced inwardly and, thereby, for said striker bar to contact and operate the other said switch or valve. The resultant signal from the

operation of either said switch or valve causes th immediate cutting off of power to the motor applying torque to said drum and, preferably, the immediate locking of said drum by a suitable braking or locking device. The locking of said drum prevents the dissipation of flywheel energy into said obstructed hoses, cables, rods or the like and thereby minimises the possibility of applying excessive compression or tension forces to them.

In operation, hoses, cables, rods or the like enter said drum through a tangentially disposed guide tube (shown as feature 64 in Figure 2) fixed to or formed on said control plate and, in passing through grooves in a sequence of said guide rollers, are progressively displaced into said drum annular space. Where said crowding ring and/or crowding springs are provided, the displacement of said hoses, cables, rods or the like into said drum annular space is against the urging of said crowding springs. Retraction of said hoses, cables, rods or the like is interrupted by actuation of pre-set control provisions of the type depicted in Figures 1 and 17 when retraction is complete, said pre-set control provisions acting to stop the motor (not shown) powering rotation of said drum. When extension of said hoses, cables, rods or the like is required, said drum powering motor is operated in the opposite sense and said hoses, cables, rods or the like are

friction during extension and retraction of said hoses, cables, rods or the like through said guide.

**THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:**

1. Apparatus for storing, projecting and retrieving one or more stiffly flexible hoses, cables, rods or the like, said apparatus comprising storage means in the form of two cylinders in a fixed coaxial relationship adapted for storing in the annular space between said cylinders hoses, cables, rods or th like in the form of a plurality of wound coils, said storage means being rotatable by drive means to displace said hoses, cables, rods or the like out through an open end of said annular space and thence through independently mounted guide means to exit provisions in said apparatus, said drive means being operated through control provisions.

2. Apparatus according to Claim 1 in which the radial width of the annular space between said coaxially arranged cylinders is less than fifty per cent greater than the outside diameter of said hoses, cables, rods or the like stored therein.

3. Apparatus according to Claim 1 in which said hoses, cables, rods or the like are guided from the open end of the annular space between said cylinders to exit means by independently mounted guide means comprising a sequence of guide rollers arranged around and over said open end of said annular space.

4. Apparatus according to Claim 1 in which said hoses, cables, rods or the like are guided from the open end of the annular space between said cylinders to exit means by independently mounted guide means comprising a progressively deepening channel arranged around and over said open end of said annular space.

5. Apparatus according to Claim 3 in which th supporting shafts of said guide rollers are arranged radially in a fixed structure independent of said cylinders.

6. Apparatus according to Claim 3 in which the supporting shafts of said guide rollers are arrang d axially in a fixed structure independent of said cylinders.

7. Apparatus according to Claim 3 in which said guide rollers are made in a sequence, each successive roller having a progressively deeper groove or progressively narrower flange to allow displacement of said hoses, cables, rods or the like from said annular space.

8. Apparatus according to Claim 1 in which means are provided to urge the coils of said hoses, cables, rods or the like towards an open end of said annular space.

9. Apparatus according to Claim 8 in which said urging means act against a ring accommodated in said annular space.

10. Apparatus according to Claim 9 in which said hoses, cables, rods or the like are attached to said ring by clamping means.

11. Apparatus according to Claim 9 in which said clamping means and other lugs project radially inwards through axial slots in said inner cylinder and act to prevent independent rotation of said ring in said annular space.

12. Apparatus according to Claim 11 in which surfaces within said inner cylinder and attached to said clamping means and lugs are used to actuate control means.

13. Apparatus according to Claim 1 in which said control provisions of said drive means comprise an a screw arranged coaxially with and driven by the rotation of said cylinders, a nut supported on said screw being axially displaced by th rotation of said cylinders to contact and trigger switches, valves or the like, the positions of which are adjustable and pre-set to terminate extension and retraction of said hoses, cables, rod or the like

at desired distances.

14. Apparatus according to Claim 1 in which said said cylinders are supported at their open ends by a plurality of independently mounted rollers.

15. Apparatus according to Claim 1 in which said inner cylinder is made detachable to facilitate the installation in said annular space of said hoses, cables, rods or the like.

16. Apparatus according to Claim 8 in which said urging means take the form of compression springs partially or wholly accommodated within telescopic tubes.

17. Apparatus according to Claim 8 in which said urging means take the form of lazy tong-type extensible elements.

18. Apparatus according to Claim 8 in which said urging means take the form of axially arranged paired bow springs optionally incorporating one or more coils.

19. Apparatus according to Claim 8 in which said urging means take the form of rat trap type springs passing substantially across the width of said inner

cylinder.

20. Apparatus according to Claim 8 in which said urging means take the form of a simple coil spring accommodated within said annular space and acting against closure provisions common to both said cylinders.

21. Apparatus according to Claim 20 in which said coil spring comprises three full turns or less.

22. Apparatus according to Claim 1 in which said cylinders are made parallel but increasing in diameter towards their open ends.

23. Apparatus according to Claim 1 in which one or more flexible guides convey said hoses, cables, rods of the like from said exit means to an operator's handpiece or work head.

24. Apparatus according to Claim 23 in which said operator's handpiece incorporates control provisions to allow remote control of the invention.

25. Apparatus according to Claim 23 in which said flexible guides are each made with a replaceable coiled wire liner to reduce friction during extension or retraction of said hoses, cables, rods or the

like.

26. Apparatus according to Claim 1 in which said inner cylinder is made longer and two outer cylind rs are supported at the ends of said inner cylind r, the inner ends of said outer cylinders being separated by a circumferential gap, hoses, cables, rods or the like being stored in the annular space between said inner and outer cylinders and extended and retracted through a sequence of independently mounted guide rollers disposed around and over said circumferential gap to guide said hoses, cables, rods or the like to or from exit means.

27. Apparatus according to Claim 11 and Claim 26 in which rings incorporating clamping means and lugs are urged towards each other by axially arranged tension springs.

27. Apparatus according to Claim 1 in which means are provided to detect the imposition of excessive forces upon said hoses, cables, rods or the like.

28. Apparatus according to Claim 27 in which said force detecting m ans comprise a grooved roller supported on the end of a moveable plunger, a curved part of said hoses, cables, rods or the like passing through the groov of said roller such that excessive

compression or tension forces imposed upon said hoses, cables, rods or the like cause their said curved parts to be displaced, thereby displacing said plunger against the urging of centralising springs and causing a striker bar attached to said plunger to contact switches, valves or the like and thereby to actuate provisions to relieve said excessive forces.

29. Apparatus according to Claim 28 in which said provisions to relieve excessive forces in said hoses, cables, rods or the like include valves or switches to cut off power to said motor driving the rotation of said cylinders and valves or switches to actuate provisions to rapidly brake or arrest the rotation of said cylinders.

30. Apparatus according to Claim 1 in which said inner or outer cylinders are contructed from a plurality of axially arranged rods to approximate a cylindrical shape.

31. Apparatus according to Claim 1 in which said inner or outer cylinders are contructed from foraminous sheet material.

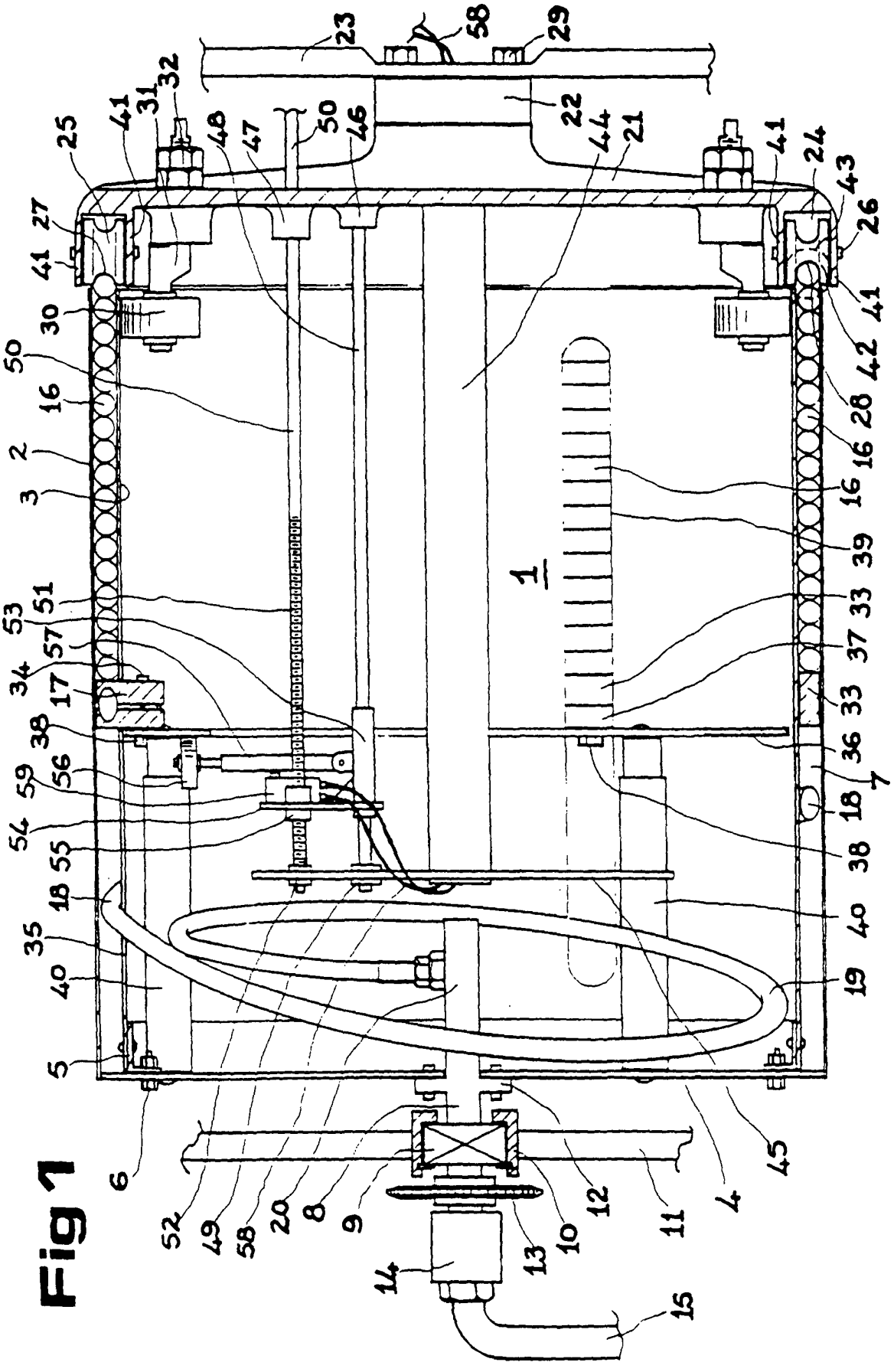
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Fig 1

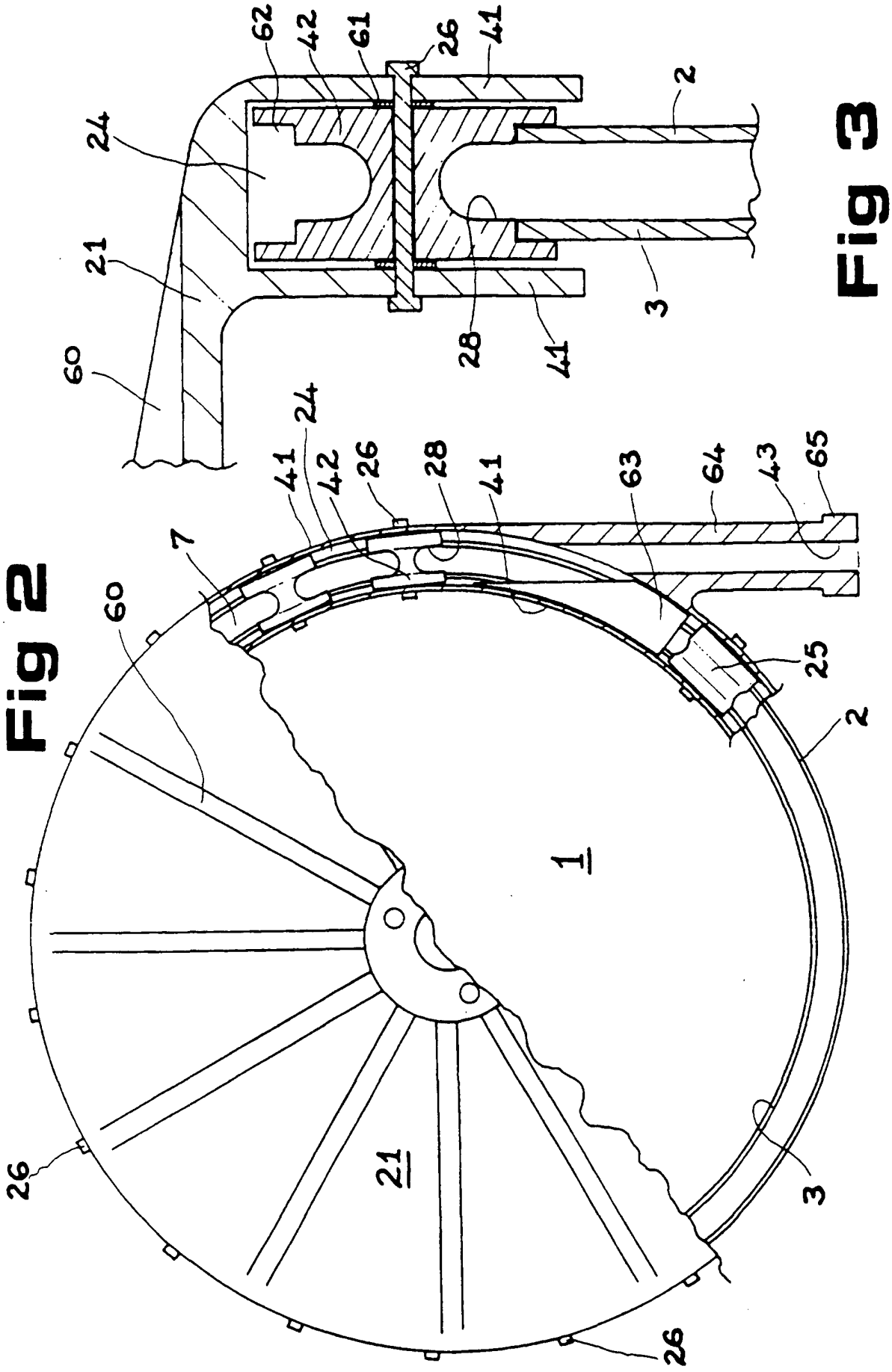
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Fig 2

Fig 3

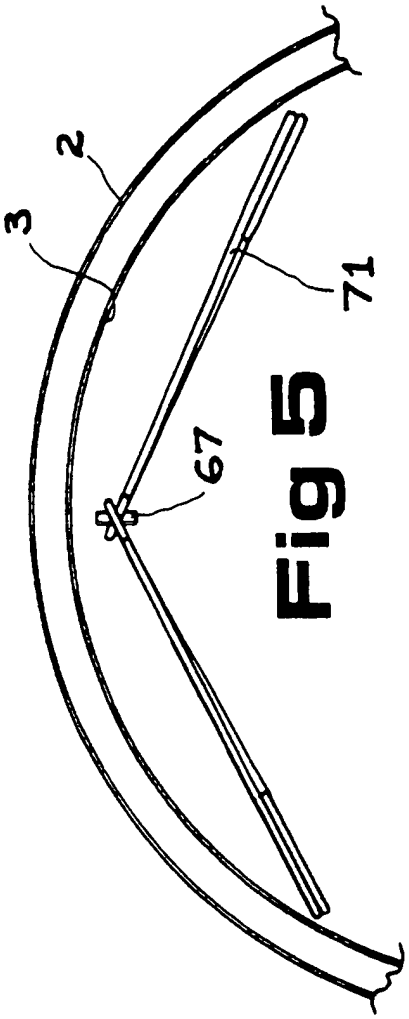



Fig 5

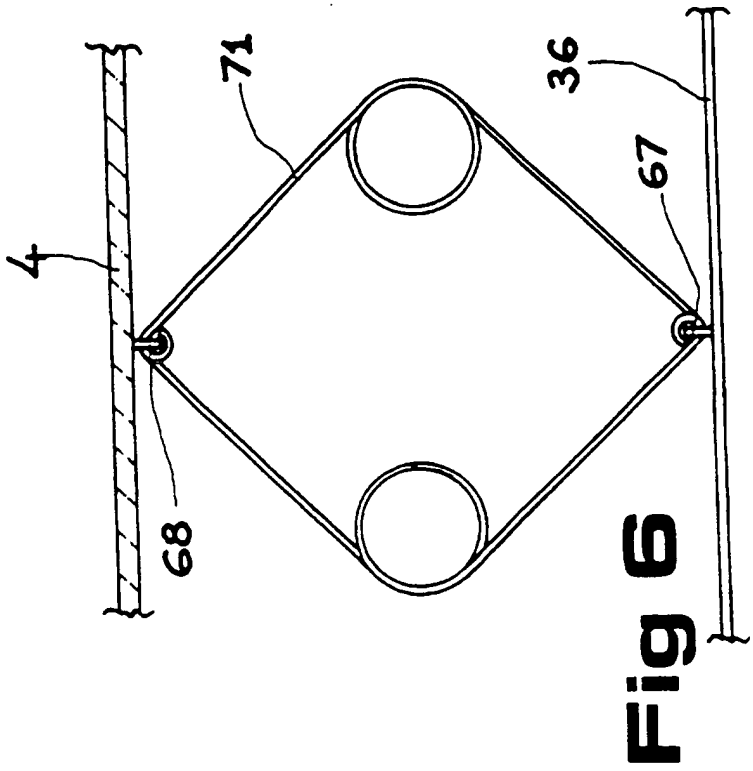



Fig 6

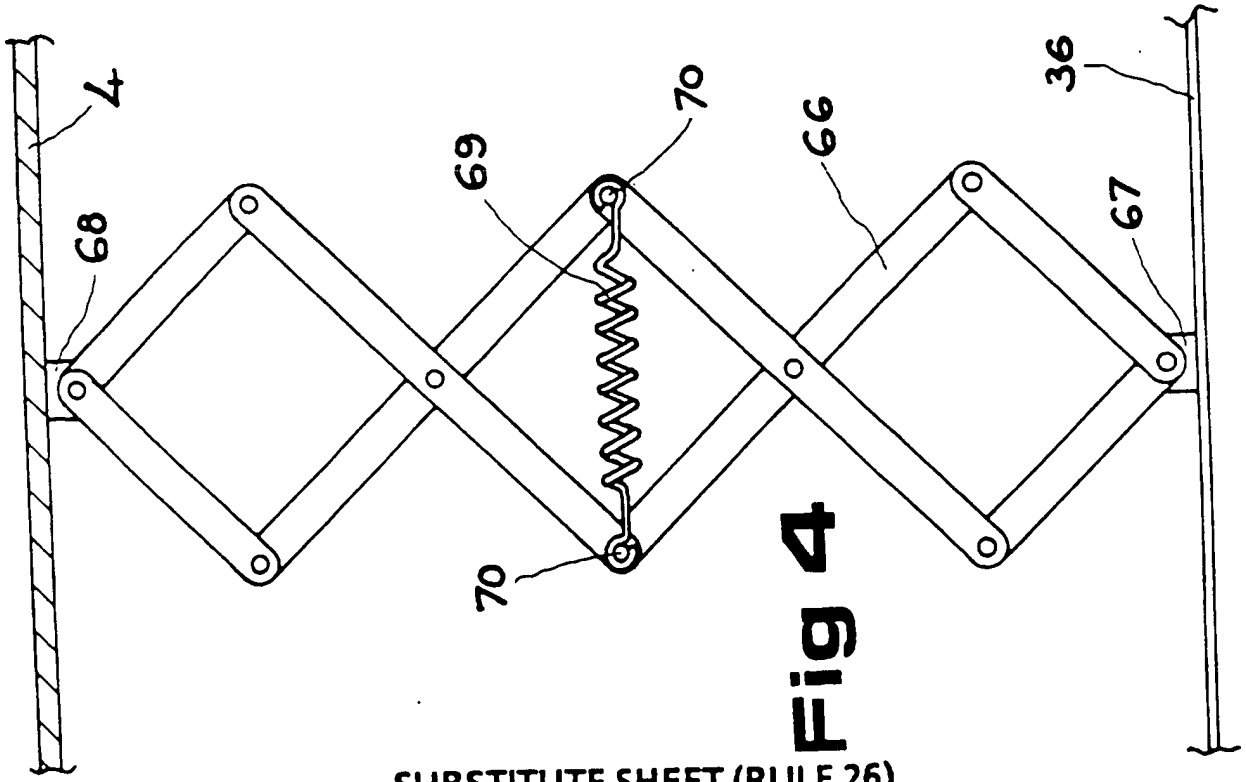



Fig 4

Fig 8

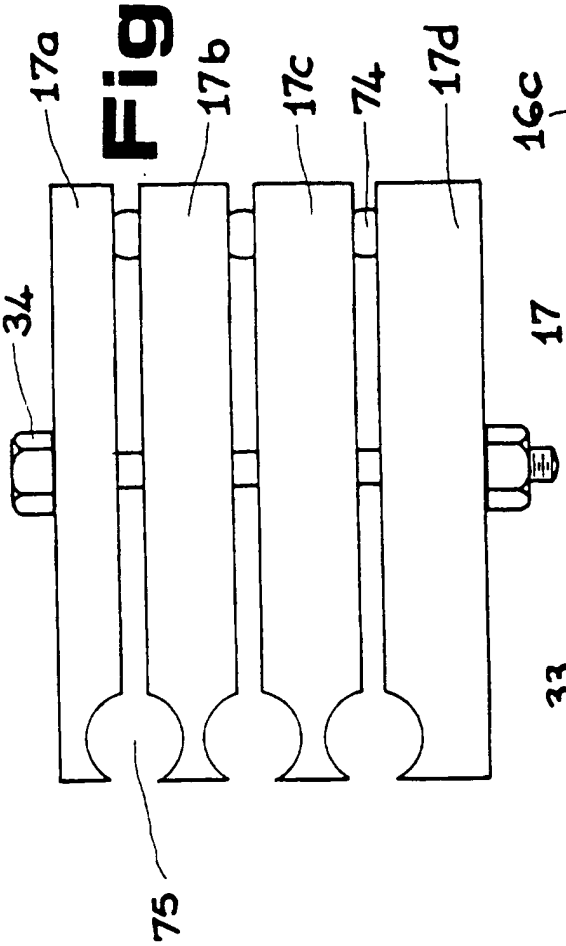



Fig 9

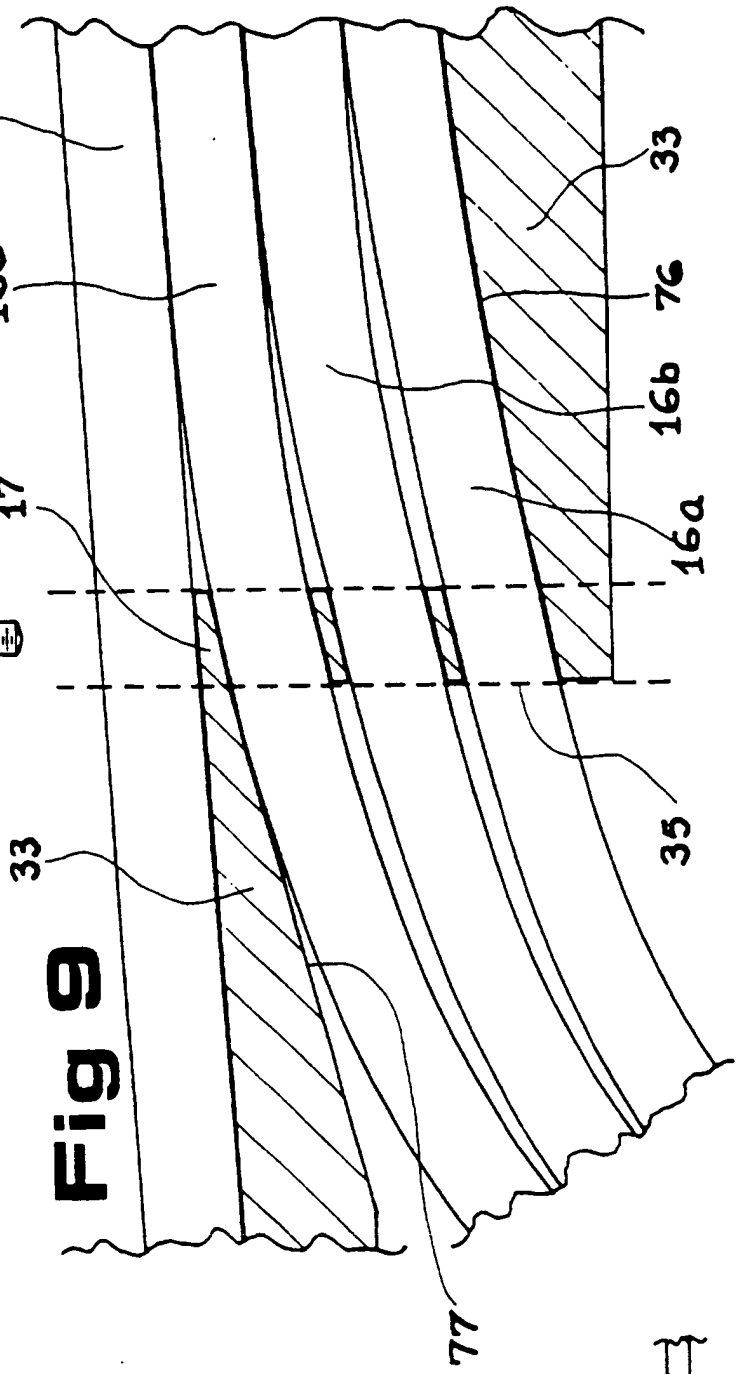
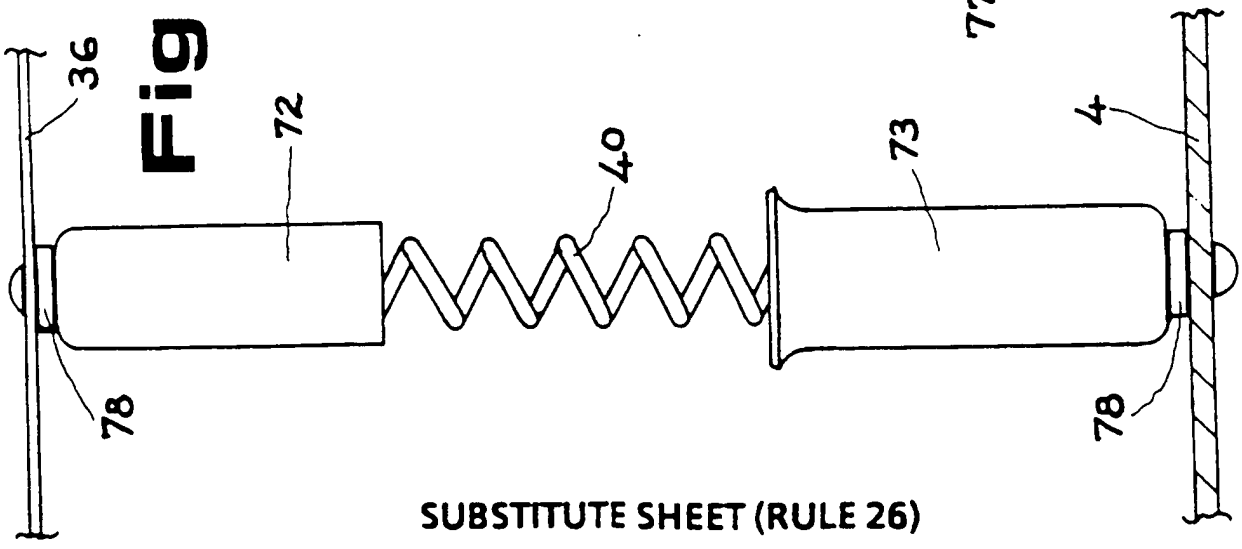



Fig 7



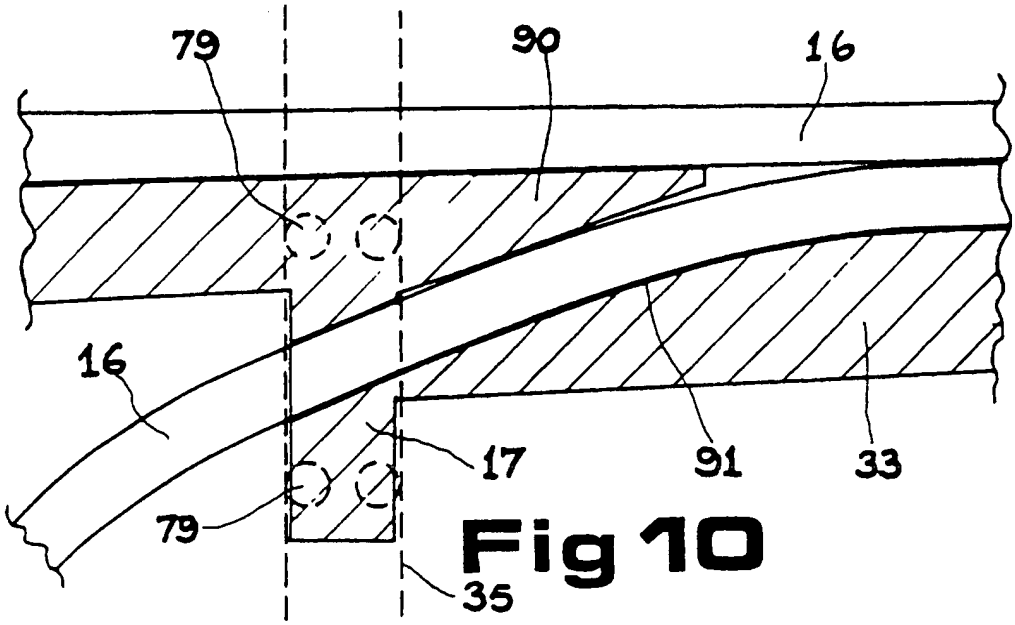
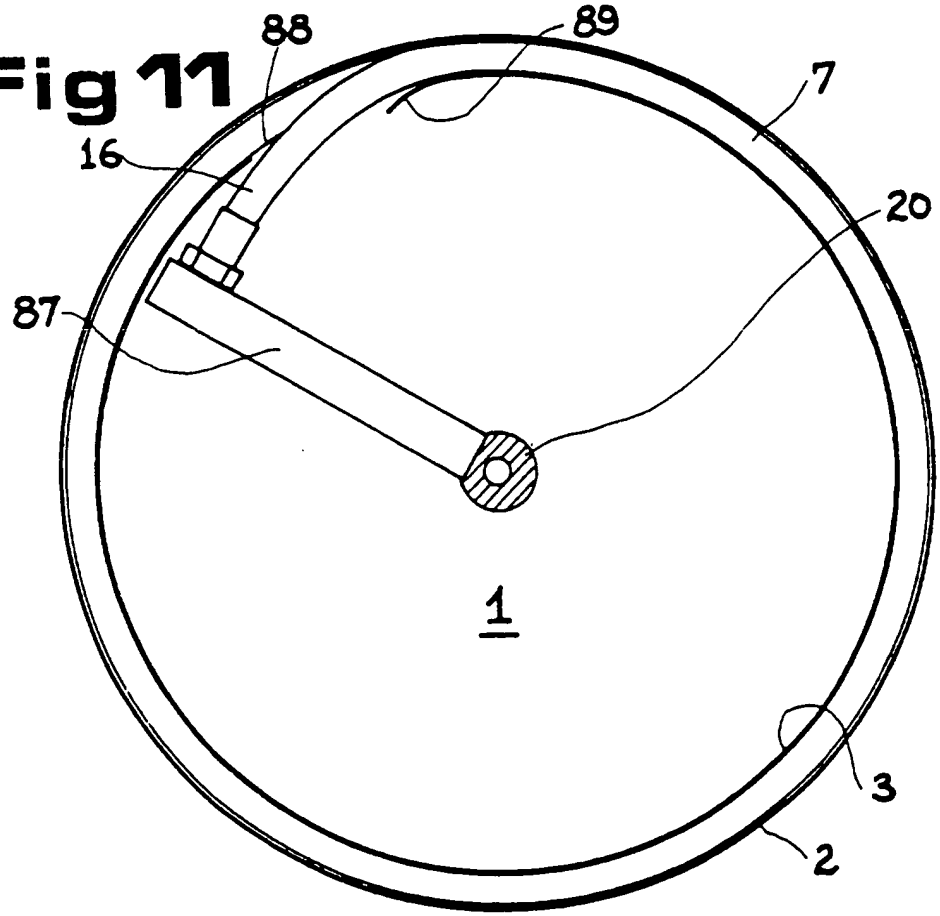



Fig 10

Fig 11



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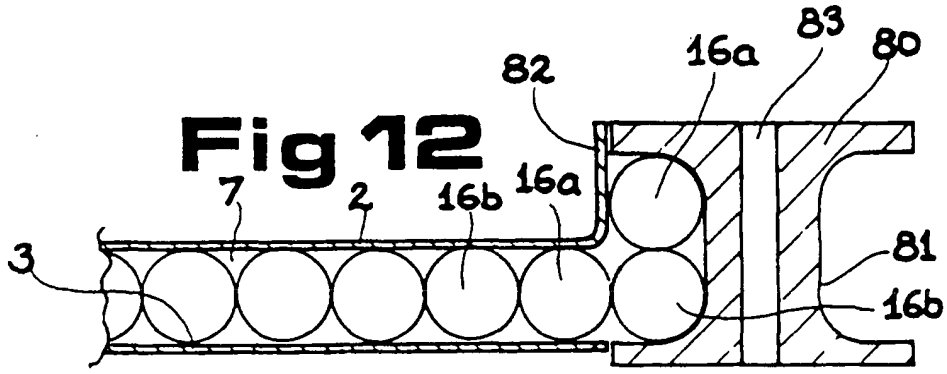
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Fig 13

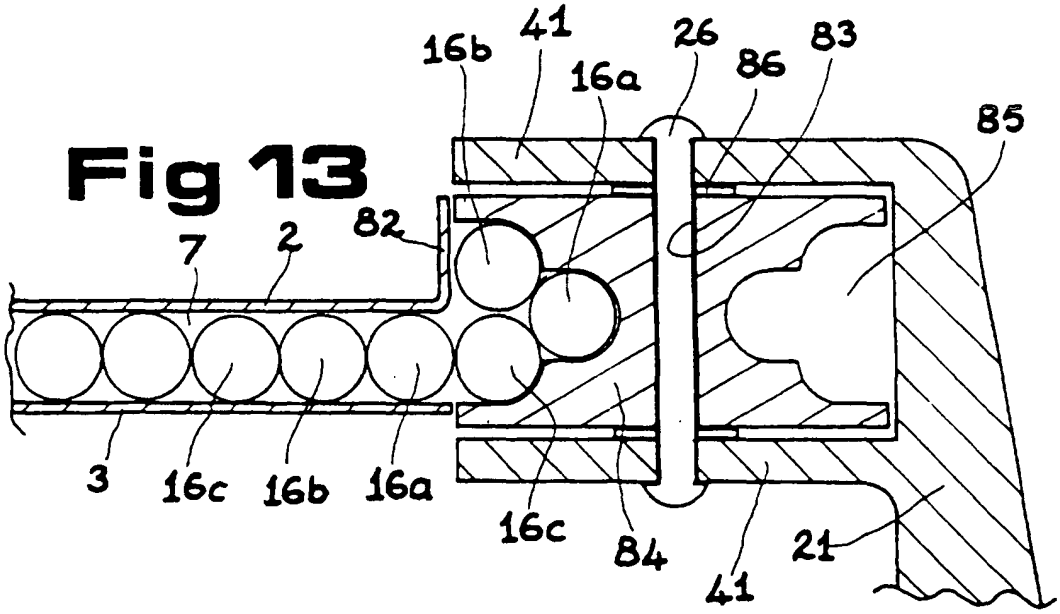
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Fig 16

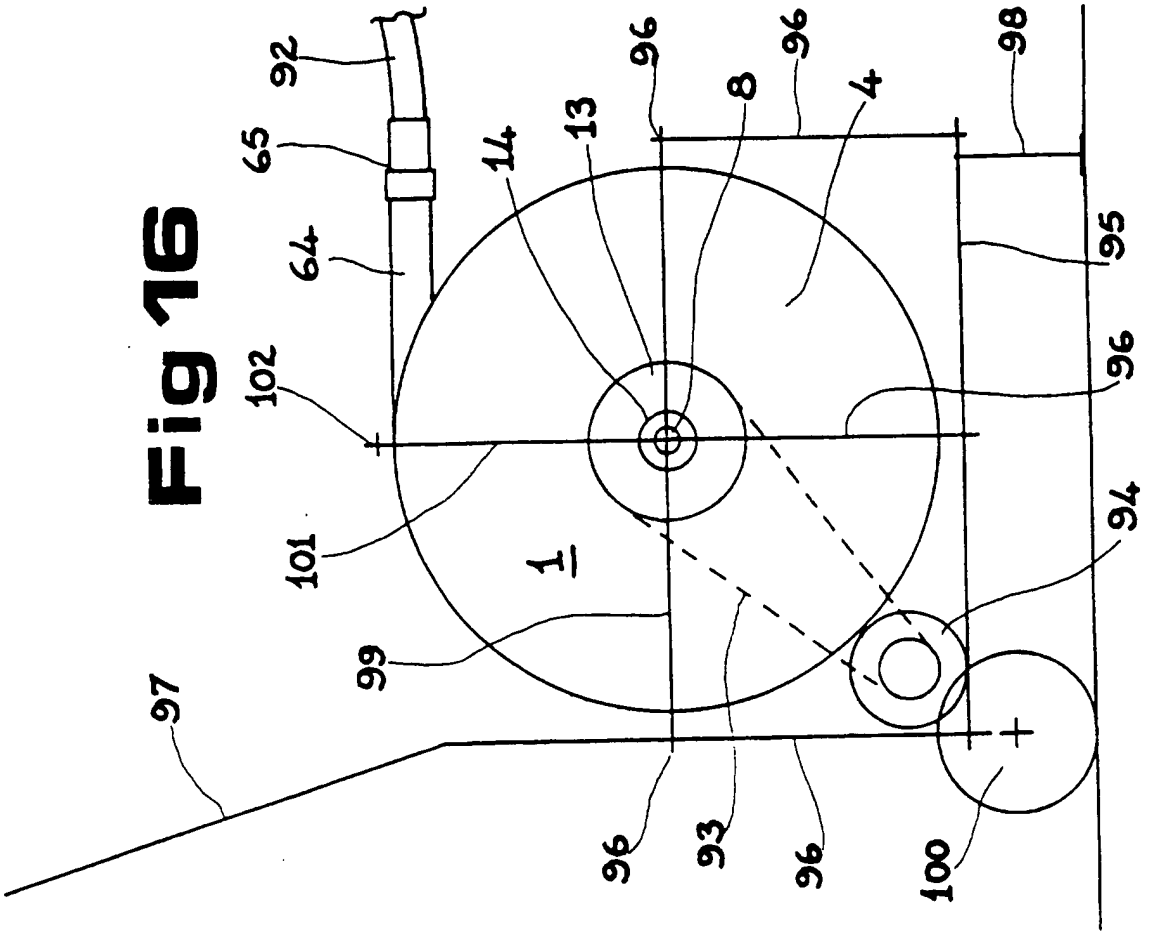



Fig 14

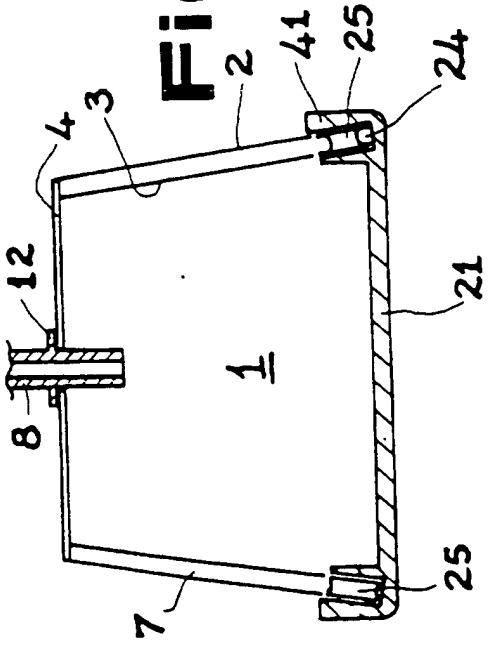



Fig 15

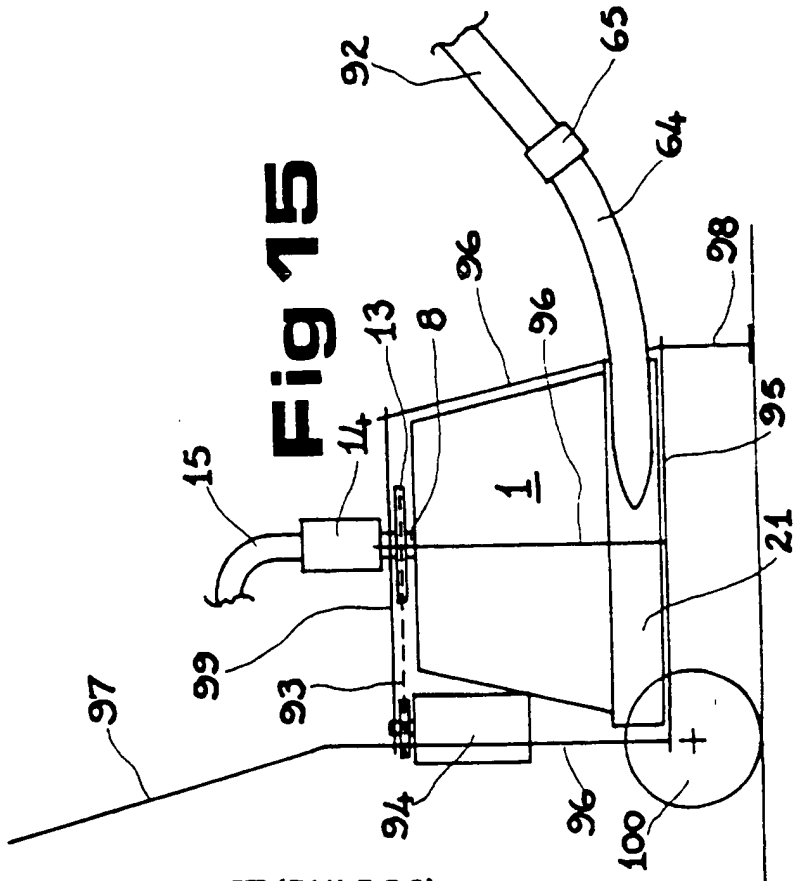
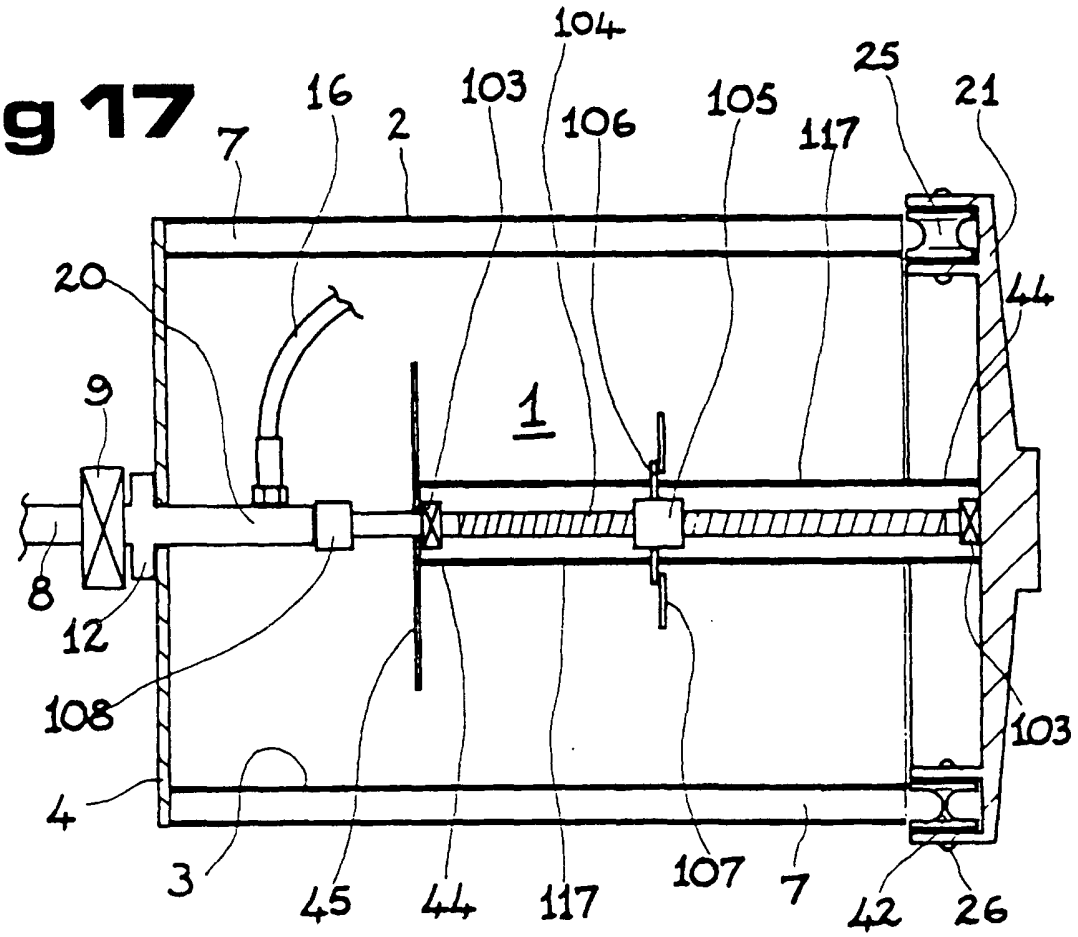


Fig 17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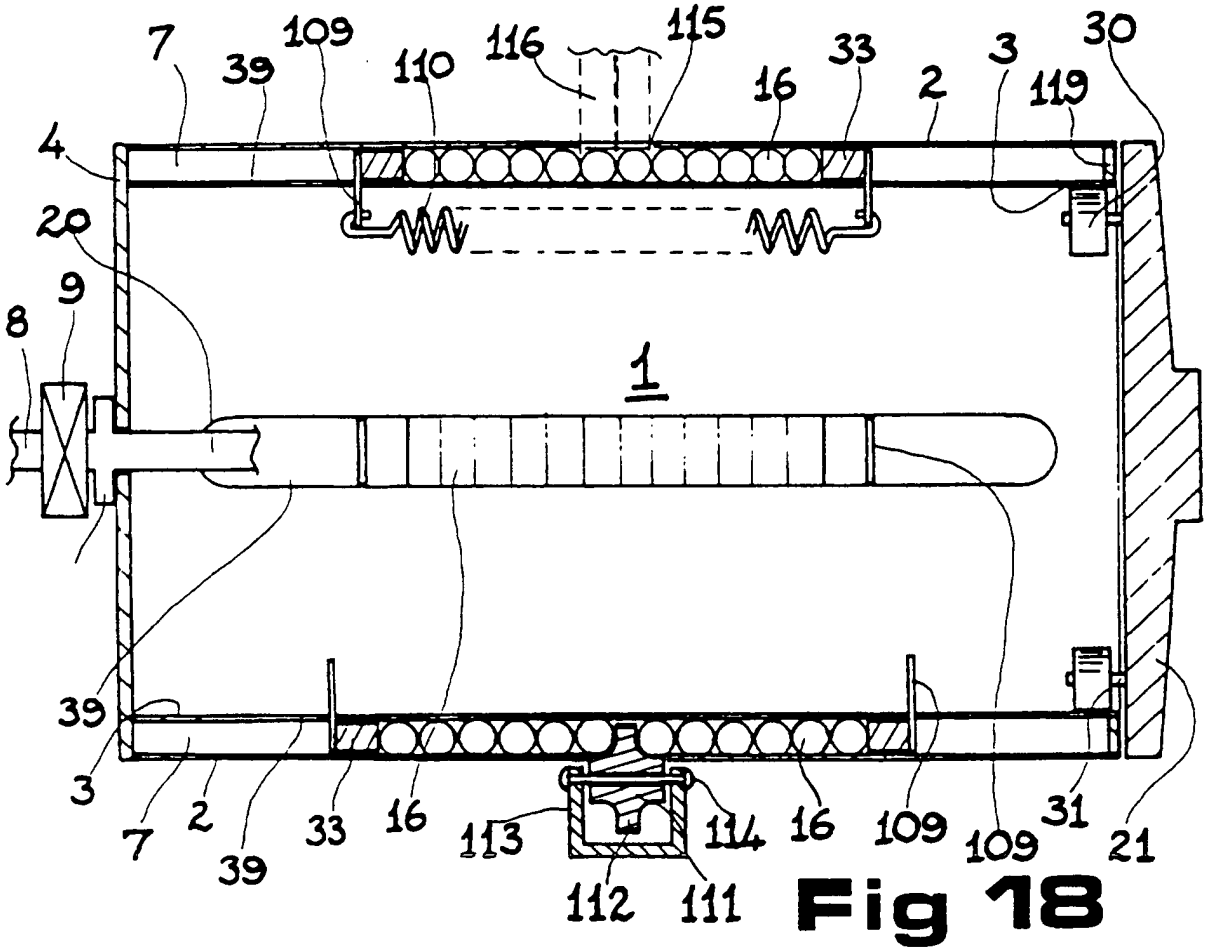
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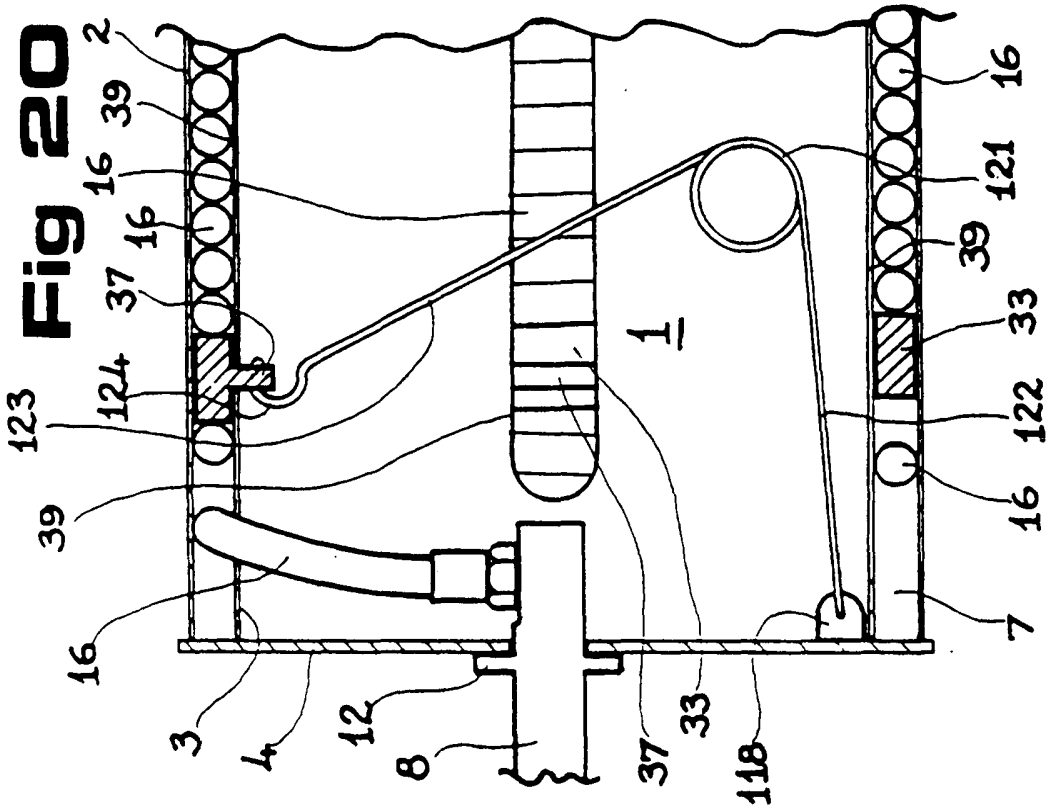
Fig 18

Fig 20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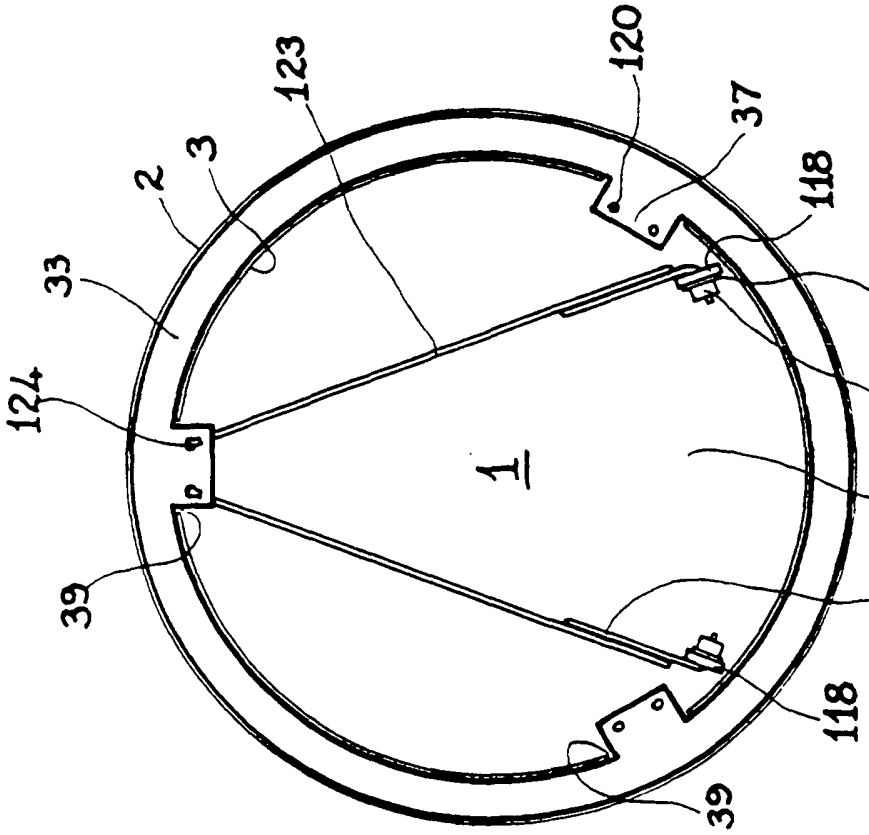
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Fig 19

Fig 22

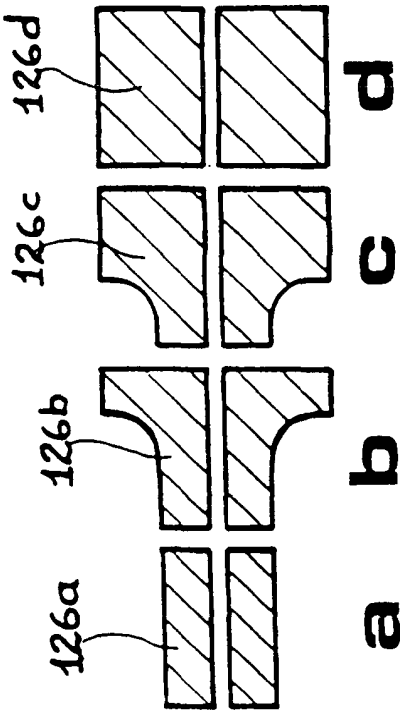
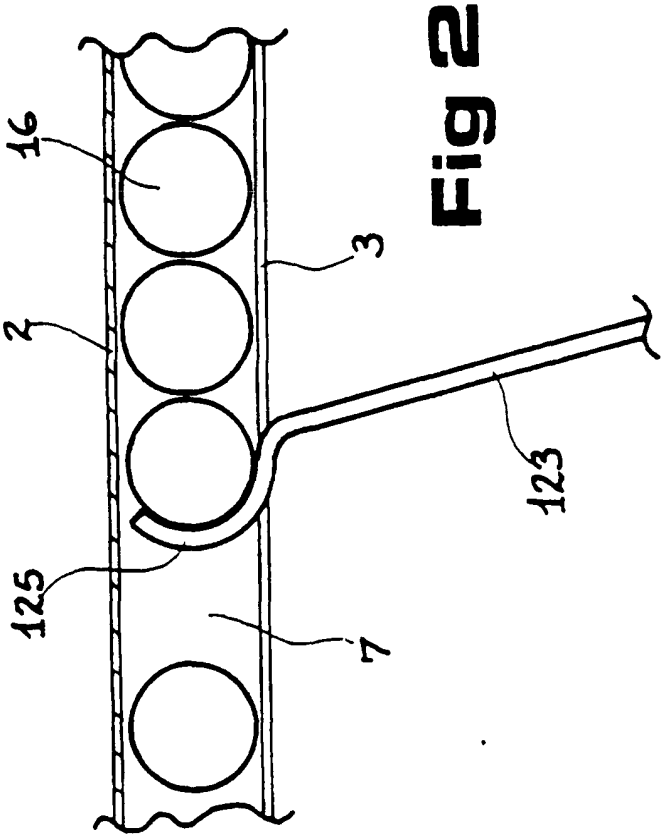



Fig 23



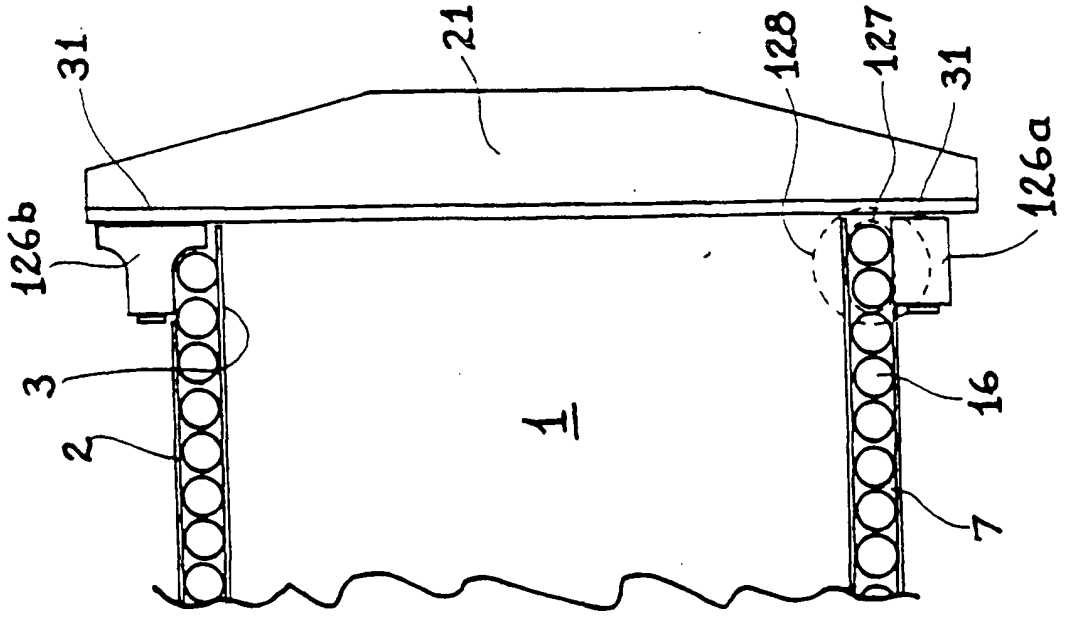




Fig 21

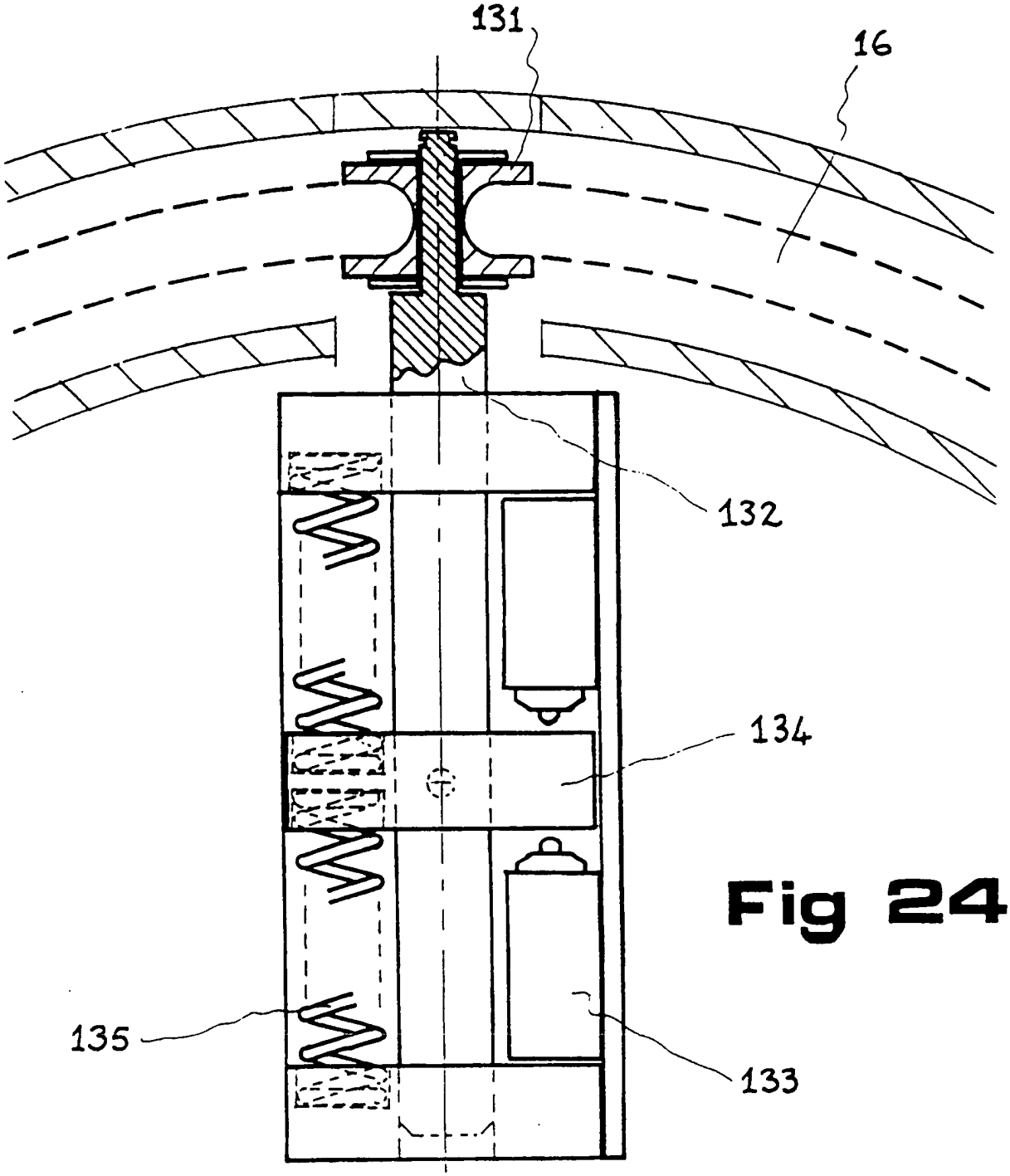



Fig 24

# INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/00769

## A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B65H 75/38 // B08B 9/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : B65H 75/18, 75/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | Patent Abstracts of Japan, M-831, page 70, JP,A, 1-43469 (HITACHI LTD) 15 February 1989<br>Abstract | 1 |
| A | Patent Abstracts of Japan, M-1211, page 80, JP,A, 3-256974 (HITACHI LTD) 15 November 1991<br>Abstract | 1-31 |
| A | WO 92/07786 A (BARRY BROTHERS SPECIALISED SERVICES PTY LTD) 14 May 1992<br>Figures 1-2 | 1-31 |

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 22 January 1996 | 9 FEB 1996 |

| Name and mailing address of the ISA/AU | Authorized officer |
|---|---|
| AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION<br>PO BOX 200<br>WODEN ACT 2606<br>AUSTRALIA Facsimile No.: (06) 285 3929 | J. HO<br>Telephone No.: (06) 283 2329 |

PCT/ INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/00769

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | WO 90/12267 A (BARRY BROTHERS SPECIALISED SERVICES PTY LTD) 18 October 1990<br>Figure 1 | 1-31 |
| A | GB 2275041 A (BENTHOS INC) 17 August 1994<br>Entire document | 1-31 |
| A | US 2478540 A (MARTIN) 9 August 1949<br>Entire document | 1-31 |
| A | WO 91/11384 A (SAAB MISSILES AG) 8 August 1991<br>Figures 1-5 | 1-31 |
| A | US 5067558 A (BOISTURE) 26 November 1991<br>Column 5 line 43 - column 6 line 66 | 1-31 |
| A | US 5022463 A (BOISTURE) 11 June 1991<br>Figures 3-5 | 1-31 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/AU 95/00769

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in Search Report | | Patent Family Member | | | | | |
|---|---|---|---|---|---|---|---|
| WO | 9207786 | AU | 87545/91 | BR | 9107053 | CA | 2094385 |
| | | EP | 555277 | JP | 6502377 | | |
| WO | 9012267 | AU | 54192/90 | BR | 9006412 | CA | 2031205 |
| | | EP | 424487 | JP | 3505627 | US | 5099911 |
| | | US | 5265671 | AU | 54192/90 | | |
| GB | 2275041 | | | | | | |
| WO | 9111384 | AT | 104924 | DE | 69008525 | EP | 466891 |
| | | SE | 9000230 | US | 5257746 | | |
| US | 5067558 | US | 5002120 | US | 5022463 | US | 5031691 |
| | | US | 5129455 | | | | |
| US | 5022463 | US | 5002120 | US | 5031691 | US | 5067558 |
| | | US | 5129455 | | | | |

END OF ANNEX